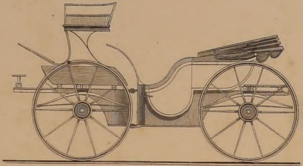

EQUIROTAL DROITZSCHKA.

PLATE XI.

ENGLISH
PLEASURE CARRIAGES;

THEIR

ORIGIN, HISTORY,
VARIETIES, MATERIALS, CONSTRUCTION, DEFECTS, IMPROVEMENTS, AND CAPABILITIES:

WITH AN

ANALYSIS OF THE CONSTRUCTION OF COMMON ROADS AND RAILROADS, AND THE PUBLIC VEHICLES USED ON THEM;

TOGETHER WITH

DESCRIPTIONS OF NEW INVENTIONS.

ILLUSTRATED BY NUMEROUS DESIGNS,

FOR THE USE OF CARRIAGE PURCHASERS AND CONSTRUCTORS.

BY

WILLIAM BRIDGES ADAMS.

"He would fain keep a hold on the Actual, knit the New securely to it, and give to them conjointly a just direction. * * * * He recognizes motion as the true element of humanity, and principle of the universe."

Characteristics of Goethe.

LONDON:
CHARLES KNIGHT & Co. LUDGATE STREET.
1837.

LONDON:
PRINTED BY SAMUEL BENTLEY,
Dorset Street, Fleet Street.

PREFACE.

THE object of this work is general utility, rather than technical instruction in minor details. The principles on which carriages ought to be constructed, rather than the arbitrary proportions of parts, are what the author has sought to make clear. The utmost care used in giving accurate measurements, with considerable labour to the writer, and more to the reader, would fail in enabling a mere copyist to construct a good carriage, and a builder with clear ideas would not need them. In architecture, there are certain rules laid down by which all proportions may be regulated; but in carriages, so many considerations intervene, as to produce uncertainty, what actual strength may be required. Seasons, localities, weight, speed, and many other circumstances, conspire to defy precise calculation. The builder of a steam-engine knows to

a fraction the amount of strain his work will have to bear; but the carriage builder canonly take average proportions to meet varieties of circumstances, unless his vehicle be intended for a railroad.

The writer makes no pretension to set a complete work before the reader; circumstances rather than original intention have caused the book to be produced, just as Mr. Babbage in the pursuit of a specific object acquired a mass of general knowledge, which he afterwards gave to the world, for the benefit of those who might not have the opportunity of collecting it as he had done. The writer, when a boy, was "brought up," in the usual phrase, to the "art and mystery of coachmaking," and acquired the common amount of routine skill in imitating certain prescribed forms; but as to the principles of the art,—as to the mode of originating the forms, he was left in utter ignorance. In fact, those to whose instruction he was confided were as ignorant as himself. Had the patterns of the factory been destroyed by accident, the business must have stopped, unless external talent had been brought in to renew them. Impatience of mere routine excited in the writer the desire of becoming familiar with other branches of the art, and he acquired something of skill in many varieties of work. Circumstances afterwards brought him into connexion with an eminent engineer,

and a new world seemed to open upon him, gorgeously decked in all the wonders of machinery. The minds of most boys are essentially inclined to the material; they prefer the real to the imaginative,—utility in art, to taste or splendour in art,—and feel far more interest in Robinson Crusoe's canoe than in a Lord Mayor's barge. Thus, after becoming familiar with the properties even of simple machines, the inferior mechanical construction of carriages became an object of contempt to the writer; and taste for beauty of form not having been awakened in him, he ceased to feel any interest in them. His daily occupation became a drudgery to him, to which almost any other employment seemed preferable: and the simple reason was, that he had no scope for improvement, no exercise for advancing intelligence. The motive of the writer in recording this is, that the same mischievous system still prevails, though opportunities for self-improvement are more numerous than before. Ere he had well attained mature years, the writer was obliged by ill health to seek a more genial climate than his own, and he passed several years alternately sojourning and travelling in various countries, where perceptions of the beautiful in Nature and in Art gradually began to stir and awaken his dormant faculties. Being thrown much on his own resources in mechanical difficulties, his invention was fre-

quently tasked in various ways; and the excitement of overcoming obstacles served to stimulate his perseverance, and quicken his observations as to mechanical capabilities.

When the writer returned to England with renewed health, he entered into partnership with his father, in the firm of Hobson and Company, of Long Acre. For a considerable time he applied himself to the mercantile department of the business, after which, [illegible] circumstances gave him leisure to pursue systematically a series of mechanical improvements, as well as to study the principles of the art of vehicular locomotion. He sought for books to aid him; but the knowledge to be gleaned from them was so imperfect, and so extensively scattered, so devoid of all system, and so very unsatisfactory, that he chose rather to seek the practical school of the workmen, and the verification of experimental research, and thereon to build his own theories. Having accumulated the results for his own satisfaction, it struck him that information acquired with so much trouble must be valuable to a large class of readers, both the constructors and purchasers of carriages. Further reflection convinced him that a succinct detail of the progress of wheel carriages in England from the earliest period down to the present time would be a desirable addition, and the result is

been the publication of the work now offered to the reader.

Whatsoever may be the imperfections, the writer cannot doubt that, in the absence of any existing available work on the subject, the information herein collected will be esteemed valuable by the large and increasing class of those who keep carriages, whether for their own use or for the purpose of hiring out to the public. Whoever is about to build a house endeavours to procure drawings and models beforehand, to make sure that his fancy may not lead him astray; and carriages being articles of considerable expense, it must surely be desirable to acquire such knowledge as a book can give on the subject, previous to making a purchase. To constructors, this work must be useful, even to those who might feel inclined to contest any of the positions the writer has laid down; for it will give them the opportunity to verify anything which they find not borne out in practice. It may perhaps induce some one of greater skill than the writer to put forth another work. He would be glad to hail such a work as might be worthy of being entitled *The Science of Vehicular Locomotion.* In the mean time, constructors residing at a distance from the metropolis, and those of foreign lands, will probably avail themselves of the opportunity of knowing the existing state of the art of carriage construc-

tion in the English metropolis, where it is generally supposed to have attained its nearest approach to perfection. If there be any constructors so illiberal as to suppose this injurious to their interests, they will do well to reflect that ere foreigners can rival English constructors, they must train their workmen in every branch, direct and indirect, to posses greater skill than English workmen. The circulation of English models on the Continent would tend perhaps to improve the Continental manufacture; but they would to a greater extent tend to increase the already extensive taste for English carriages.

As this work may occasionally fall into the hands of readers who feel no direct interest in pleasure carriages either as purchasers or constructors, some may perchance be inclined to question its utility, except as it relates to the mechanism of vehicular locomotion. They may perchance condemn pleasure carriages altogether, as luxuries unjustly engrossed by wealthy people. This would be as unjust as the sweeping condemnations so frequently passed on the public vehicles in the streets. Pleasure carriages are instruments of elegant human enjoyment; and to say that none ought to enjoy them because all cannot enjoy them, would be to possess a spirit akin to that of the "dog in the manger." If those who possess pleasure carriages were to enjoy them at the expense of those who do not

possess them, the evil would be a monstrous one: but such is not the fact. Partial instances might be adduced; but they are only exceptions to the rule,—as, for example, the case of a swindler. But, after all, those who do not use pleasure carriages—as the mass of the community—though they do not benefit directly, still benefit indirectly by them. They are objects of beauty constantly exposed to public view, as much so as architectural erections—perhaps more so, being locomotive,—and far more so, though in a humbler way, than paintings or statues. It is an undeniable fact, that the daily habit of beholding beautiful objects has an imperceptible effect in refining the national taste. Pleasing colours and pleasing forms tend to soften rugged natures; and whatever may be the disputes as to the evil or good resulting to a nation from the existence of a permanent leisure class, it is quite certain that if no part of the community be at leisure to study the arts of elegance, the public will be far less refined, far more devoid of taste, than if they have a standard—a type, as it were, to imitate, when any individual may acquire the means to imitate, without understanding the principles of that which he imitates.

In most branches of art, men of vulgar minds are to be found who deem that art is on the decline because works of art are progressively diminishing in price, forgetting

that an increasing demand more than compensates for a decreasing price. Amongst carriage constructors men of this class may be found, who prophesy the decline of carriage building in England, because they cannot maintain a lazy monopoly. They obstinately shut their eyes to the fact that the streets of London are now occasionally blocked up with pleasure carriages, as they frequently are with carts. The simple fact is, that ordinary skill is now common, and carriage builders have become a more numerous body. It is a more difficult thing than formerly to stand out from the crowd, and it can only be accomplished by combined talent and energy. The arts of elegance, or luxury, as they are sometimes called, will be pursued with more earnestness than ever as people advance in wealth; and if there be a fear, it is, lest the arts of wisdom be neglected for the pursuit of external enjoyment, as is so much the case in the wealthy cities of the United States.

Porchester Terrace, Bayswater,
June, 1837.

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ENGLISH PLEASURE CARRIAGES.

INTRODUCTION.

Locomotion. — Animals — Raft. — Canoe — Sledge — Palanquin — Litter — Rollers. — Solid Wheels. — Cart. — Primitive Car. — Portuguese Car. — Chilese Car. — Framed Wheel. — Axle. — Pampa-Carts. — Turning Carriage. — Ancient Coach Springs. — Strapped Seats. — Swinging Braces. — Buenos Ayres Travelling Carriage. — Wooden Springs, used in Canada. — Johnson's Waggon. — Steel Springs.

THE nature of man is progressive, and constantly prompts him to take advantage of all favourable circumstances in order to lessen his painful labour—to mitigate as much as possible the "primeval curse" by the exercise of his great sustaining faculty, reason. Next to speech, and its kindred arts, reading and writing, the power of locomotion is the most important agent in human civilisation; and, as a consequence, facility of locomotion is highly desirable. If locomotion be painful to a human being, the minimum of it will be performed; if it be easy, the maximum will be performed, inasmuch as the power of seeing new faces, places, scenery, and other objects, is desired by almost all human beings; and this desire is only kept in abeyance by the consciousness or the fear that the pain caused by indulging it will be greater than the pleasure arising from its gratification.

The earliest and simplest means of locomotion were the

same in human beings as in the lower animals—the muscular action of the limbs. So long as the muscles continue elastic, the act of walking is a source of pleasure; but when they become languid and relaxed, it is a source of pain. The frequent necessity of continuing locomotion after the muscles have become fatigued, must have set human invention at work at a very early period of the world to devise a remedy. The simplest remedy which presented itself,—the easiest transition from actual pain to comparative comfort,—was that of substituting for human muscles, the muscles of the lower animals; in short, the act of subjugating such of the lower animals as were sufficiently powerful, to human control, and obliging them to carry a human burden. Thus commenced the art of riding. Horses, asses, mules, camels, dromedaries, elephants, and even cows,* have been used to ride on in various countries and localities, according as they were found or adapted. Some of these, as the four former, may be trained to such ease and grace of movement as to give pleasure to the rider; consequently they are still used even where no positive necessity exists. The three latter, on the contrary, are painful to ride on, and ungraceful in their gait; consequently they are only used in the absence of any better means of locomotion. The wild Arab only chooses the bone-shaking dromedary in preference to the horse, when the desert is too broad for the horse's powers of endurance.

But though the act of riding on the back of a dromedary be only a lesser evil than walking, and though the act of

"* The chief of the Gallas galloped off on his cow."
BRUCE'S *Abyssinia.*

riding on the back of a horse be a positive pleasure, still it is not a pleasure at all times, nor to all persons. The muscles of a horse become non-elastic on a long journey, and the act of riding a tired horse, if not more painful, is only one degree less painful than walking with tired legs. Besides this, horses vary, both in their tempers and physical qualifications, and it is as great a pain to ride some, as it is a pleasure to ride others. In short, as a means of simple locomotion, for the purpose of a long journey, a horse's back is, to the majority of human beings, a very imperfect mode of conveyance. It is only in the vigour of youth, when the animal spirits are predominant, or by the possessors of hardy frames and enduring constitutions like the Tartars, and some few individuals of other nations, that riding horses are preferred to other and easier modes of locomotion, when a choice can be attained. The old, the infirm, the feeble, the idle, the luxurious, the careful, the calm, the industrious, the sedate, and the economists of time and strength, though they may all in turn ride on horseback for the purposes of pleasure or exercise, will invariably prefer, as a means of simple locomotion, whatever method may offer the maximum of speed, with the minimum of bodily exertion, and consequently diminished wear of the animal economy.

The first attempt at vehicular locomotion must necessarily have been imperfect. Human beings residing on the banks of large rivers would naturally observe the facility wherewith trees and other vegetable productions floated on the surface, moving with the downward current. After this, the construction of a rude raft would be an easy

transition. At the present day, there exist people who go out fishing on rafts constructed of bundles of dry rushes.* A long period probably elapsed ere the invention of the oar or paddle, for the purpose of moving *up* the stream, induced the river travellers to construct, first a raft, and then a canoe, which might be worth preserving as a property of constant utility. But this was a mode of locomotion confined to a limited space. Vehicular conveyance by land was the most important desideratum.

The first and most simple form of it would naturally be a land-raft or sledge, which, if not heavily loaded, would move in favourable localities with considerable facility, as over dried grass, or green turf, or ice, or on the surface of hardened snow. In the northern countries both of Europe and America, the sledge is constantly used upon the snow at the present day, for which purpose it is better adapted than wheel vehicles, the great length of the two bearers preventing them from sinking in the snow as wheels would do. In the island of Madeira, the heavy pipes of wine are drawn on sledges from the mountain vineyards to the sea-ports; and part of the driver's business is, to walk by the side of them with a kind of mop, to keep the surface of the bare rock on which they run constantly wetted to diminish the friction. Another instance is the sledge used by the London brewers, and drawn by a single horse, to convey barrels of light weight. But it is evident that, except under peculiar circumstances, the friction of sledges is so great as to cause a great loss of animal power; and, therefore, better vehicles must have been objects of desire at a very early period. In mountainous

* Lake fishermen in parts of South America.

countries, sledges could scarcely be used except down hills; and accordingly, in mountainous countries, the next stage of improvement must have been first adopted.

This mode was to take the sledge altogether from the ground, on which it had been drawn by horses or oxen, and to suspend it from the backs of two or four of them, by means of pack-saddles and lashings. In Spain and Portugal, this rude vehicle is still to be found, under the form of the *litera* or litter; which is, in fact, a sedan chair borne by two mules, one before and one behind, the poles being slung to their packsaddles. In England this sedan chair is, or rather was, borne by men. In the East, the form changes from a chair to the more luxurious one of a couch, and under the name of a *palanquin* it constitutes the principal vehicular conveyance of the rich, being borne by olive-complexioned men more capable of endurance than quadrupeds in an enervating climate.

But the litter and the palanquin were alike imperfect, inasmuch as they consumed a large amount of animal power for very little effect; because the whole weight of the passenger and the vehicle also, had to be borne as well as moved along. Those who navigated large rivers in canoes, were obliged occasionally to lift them out of the water, and carry them over land wherever falls or shallows interrupted the channel. In such a case, the bearers would become sensible of the disproportion of labour existing between the act of paddling a canoe and that of carrying it, * and invention would be set to work to pro-

* On the navigable rivers in Canada, there are numerous spots marked in the maps "*Portages*." These are carrying-places for the Indian canoes, the progress of which is impeded by falls or shallows

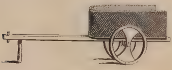
duce a similar result with a land vehicle—to find a mode of sustaining it, as the water sustained the canoe. Inventors are not creators,—they are merely finders-out; they do not make new forms,—they merely take the types which exist in nature. He who cut down trees on the hill-side to build his house in the valley would naturally remark the facility wherewith the round trunks rolled to the bottom of the hill, and also the ease with which they could be moved over the level, when compared with flat logs or large blocks of stone. This was doubtless the origin of rollers or round logs of wood, which are placed under heavy trees or beams in order to move them over the surface of the earth. To set in motion trees thus placed, it is necessary to apply a lever. This would not be a tedious process of discovery, after the example of the paddle, which acts as a lever in the water. But turf or soft ground would prove a very inefficient fulcrum to rest the lever on, and the next process would naturally be that of cutting a hole through the roller in which to insert the lever. The convenience of several holes in the circumference of the roller would then become apparent, and thus would be formed an embryo wheel nave. It could not fail to be remarked also, that the larger the roller, the greater the facility for turning it, and consequently the greater the load that could be borne upon it. But there are few trees whose stems are found of large size and of a cylindrical form; without which latter condition, they would not roll in a straight line, but in the circumference of a circle of greater or lesser size; and besides, the weight of very large solid rollers would be a great disadvantage. Under these circum-

stances, it would soon be remarked, that it is not essential for rollers to bear on the earth throughout their whole length;—that it is sufficient if they bear at the extremity, with just so much surface as is necessary to prevent them from sinking into the ground. Most trees are found to possess the largest diameter just above the spread of their main roots. It would soon occur to those who wished for large rollers, that if a short length were cut from one of the largest trees at this spot, it might be joined to a similar one at the needful distance by means of a cross beam inserted in a hole in each. This, supposing the cross beam to be fixed in square holes, would be the rude outline of a pair of wheels and an axle, of precisely the same *principle* as those used on the Manchester and other railroads at the present day, and also by the rustic cultivators and town carmen of Portugal.

Possessing this wheel and axle, it would be a very simple process to round the axle cross beam, and place a frame on it capable of carrying burdens, the axle being confined to perform its revolutions at or near the centre of gravity* of the frame, by thole pins or guides similar to the rowlocks of a boat. The form of the frame would be a central pole or beam, sufficiently long to bear the bulk or volume of the load, and also to project forward between the two draft horses or oxen. Parallel with the central beam would be ranged two side bearers, and these would

* The motive for choosing this precise position on the axle, is to balance, or nearly balance, the frame, in order that the weight may not unduly press on the horses' backs, or have a tendency to lift them from the ground.

be connected together by cross framings or diagonal braces. This then would be a car or cart, the simplest possible form of a wheel carriage.



CAR OF PORTUGAL.

But it would soon be discovered that a cart thus constructed runs best in a straight line, and that to turn it in a circle, unless it be a circle of very large size, causes an immense quantity of friction. The reason of this is, that in the act of turning, one wheel has a tendency to revolve faster than another, the outer track being longer than the inner one. To obviate this difficulty, the cart-maker or driver would soon contrive that each wheel should revolve on its own centre. Instead of fixing the cross beam or axle in a square hole, they would contrive it to play easily in a round one of a conical form, that being the easiest form for adjustment. The principle of this cart would be precisely that of the antique cars used by the Greeks and Romans for the purposes of war and festivity, the battle, the triumph, and the Olympic games, as well as for agricultural purposes; the only distinction being in the absence or presence of ornamental work, and the general superiority or inferiority of the construction, or rather workmanship. The rude carts used by the poor peasantry

of Chile for their agricultural purposes in remote districts are constructed in the manner above described.

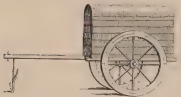
CAR OF CHILE.

It is evident that a machine made in the rude manner described could not be well adapted for very rapid motion, without a great expenditure of animal power, especially if it were much loaded. The axle being of wood, must necessarily be of considerable size; and working in wood also, a rapid motion would cause so much friction, that it would soon be cut through, even though the hardest woods might be sought and lubricating substances applied. The wheels, procured at an expense of much labour, would quickly become useless; large-sized trees would become scarcer, and reducing the size of the wheels would increase the friction, already too great. To provide a remedy for this would be the next task of invention. The roller, with the lever-holes cut through and around it, formerly referred to as the original of the wheel, would be again examined, and a number of levers of equal size being placed in it, would present at their extremities, the outline of a circle of great diameter. How to connect these would be the next consideration; and when the plan

of fixing felloes on was first devised, the first experiment probably gave a sample of rude and crazy workmanship, at which the makers of solid wheels would laugh in scorn, and exult when they broke down, as though to fulfil their predictions that "they could never answer." But no really useful invention can be finally put down, and some more skilful workmen, fired by ambition, would begin anew, and remedy the defects, consisting, not in principle, but in execution; and thereat all cart-drivers would cry, "Lo! a wonder!" and thenceforth solid wheels would only be regarded as matters of antiquity, and a theme for surprise, that people could have been found simple enough to make, and other people simple enough to use them.

But the new wheels, with naves, spokes, and felloes, would be liable to the same disadvantages as the solid ones—a too rapid wear. The first remedy for this would be to make the axle of softer wood than the nave of the wheel, inasmuch as a new axle could be supplied with less labour than a new wheel. As this would not be sufficient, means would be devised to cover the axle with some wearing substance which could be renewed from time to time. Nothing could be so simple or so appropriate for this as a covering of untanned neat's hide sewed on wet, and left to dry and shrink. Supplied with grease or soap, the friction of an axle thus covered would be comparatively small, and both axle and nave would remain serviceable for a considerable period. The great point of wear would be the felloes, which would be renewed as they wore. The frequent renewal of these felloes would loosen and wear the spokes, and therefore means would soon be devised to

cover the wearing surfaces of the felloes with some material capable of being renewed. In the absence of metal fitted for the purpose, wood would of course be resorted to: and the mode of applying it, would be to use a second set of felloes around the outer circumference of the first, covering each joint, and fastening them by means of treenails and wooden wedges. Precisely such wheels as these are used in the ox-carts, which form the trading caravans of the great Steppes of Spanish America.* Their height is about seven feet, in order to lessen the draught as much as possible, and also to enable them to cross the deep streams and gullies. The frame of the carts is such as before described; but on the frame a wattling of sticks is erected, six feet in height, and arched at top, the sides being thatched with rushes, and the roof covered with untanned hides. Not a particle of metal is used in their whole composition.



OX-CART OF THE PAMPAS.

* They are quaintly termed by the natives "*barcos de tierra*," i. e. "landships," inasmuch as they ply for freight, and carry provisions and water with them over the deserts.

We have now seen the most primitive specimens of open and covered two-wheeled carriages; and in the improvement of their workmanship, art would for a long period find sufficient occupation. Form and ornament would be the principal objects aimed at, and some of the beautiful results have been handed down to us in the specimens of the antique cars for the purposes of war and pleasure used by the Greeks and Romans; with the general construction of which, most persons are familiar who have been accustomed to inspect antique coins, medals, or bas-reliefs.

Beautiful as these vehicles appear in their design and harmonious curves, they were by no mean adapted to ensure ease of motion unless at a very slow pace: in fact, at a rapid pace the passenger was usually obliged to stand upright, and relieve his body from the jarring shake as well as he could, by the elasticity of his feet. Wholesome the cars doubtless were in the way of exercise, and exceedingly graceful when grouped with the fine horses by which they were drawn; but neither the old nor the infirm would use them from choice.

After or before that two-wheeled carriages could arrive at this degree of perfection, it is probable that vehicles with four wheels would be constructed for the transport of articles too bulky or too heavy for the two-wheeled vehicles; such, for example, as timber. These would be simply a frame of the ordinary kind, but of extra length; and the wheels would be of equal height, like our modern railroad carriages. It would soon be found that such carriages are not calculated to turn except in a very large space;

and some contrivance would be resorted to, to enable the fore wheels to lock round.* This process would be, to construct a double frame, one a long one with the hinder wheels affixed to it, and the other a short one with the fore wheels affixed to it, and moving or turning under the long frame, by means of the lever beam or pole, on a central pin or pivot, now called a perch-bolt. As considerable strength would be required in the under frame, and as it would be necessary to retain the upper frame at a horizontal level, it would of course be necessary to reduce the height of the fore wheels, and thus cause a mechanical imperfection, which has been perpetuated in carriages up to the present day. This imperfection consists in the increase of friction in the fore wheels, in consequence of their diminished size obliging them to perform a greater number of revolutions in the same space than the hinder ones do. Vehicles thus constructed, though they would be enabled to turn in a reasonable space, would still be awkward in a narrow street or lane, because the fore wheels would be limited in their locking or turning by the side of the upper frame which carries the load. Many of the English waggons are still constructed thus, and may be seen with an angular piece cut out of their sides, to admit a larger space for the wheel to lock in. Some of the stage-coaches also are thus imperfect in their locking, and are occasionally overset on account of it when the horses become restive and start on one side. In order to avoid this,

* The expression "to lock," as applied to the turning motion of a carriage, is not a good phrase; but custom having made it familiar, the author has thought it well to retain it.

it is necessary either to raise the upper frame, or to reduce the size of the fore wheels, so that they may turn beneath it. Either of these remedies produces a certain portion of evil ;—the former, by raising the centre of gravity to a greater height, and increasing the chance of oversetting ; the latter, by increasing the friction and consuming a larger amount of moving power.

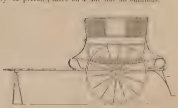
Most of the ancient coaches or covered carriages were constructed upon one plan. Two longitudinal timbers or beams, secured to two cross bars at each end by scarf joints and bolts, constituted the upper frame. As the streets of most of the ancient European cities were very narrow, the difficulty of turning or locking experienced with such carriages, led to an obvious improvement — the invention of the crane neck. The two longitudinal beams being removed, their places were supplied by two long heavy bars of iron, arched upwards in front, in the form of a swan or crane's neck, to a considerable height, so that the fore wheels when locking might pass beneath them. By this contrivance, a high fore wheel was retained, and a perfect lock accomplished ; but very considerable weight was at the same time added to the vehicle. But as coaches were only kept by the rich, who could afford abundance of animal power, this was not to them a very important defect.

Ere mechanical art reached this degree of perfection in the wheels and framework, it is probable that attempts would be made towards the development of some means for preventing the concussion arising from the rapid motion of the wheels over rough roads from reaching the bodies of the

passengers. As a concussion or shock is transmitted much more forcibly through a solid or firm medium than through an unfirm one, the simplest contrivance would be, to suspend a seat by means of straps or lashings:—specimens of this may be seen in the light carts used by butchers and others in the large towns of England. The next improvement would be, by separating the sitting part altogether from the wheels and axles and interposing a moving medium between them:—the sitting part would be made an independent frame, supported on long ropes or straps stretched beneath it, and affixed by the ends to another frame firmly secured upon the axles. The antique four-wheeled carriages of Europe used for state purposes are mostly constructed on this plan, and their great weight and slow movement prevent any violent concussion. Many of the public stage-coaches of France are suspended on the same principle, as well as those of the United States and Canada: for in the latter countries, though there is not any lack of enterprise or want of energy to improve the public vehicles, it is found by experience that the imperfect condition of the roads precludes the possibility of using steel springs with a due regard to economy.

The natives of Buenos Ayres use for the purpose of travelling a covered two-wheeled vehicle with shafts, called a *carri-coché*, or cart-coach. Horseflesh, owing to its abundance, is profusely wasted on the Pampas of La Plata. When used for draught, the horses are not harnessed: a strap or cord of raw hide is fastened to the ordinary saddle girth; and as many as are the horses fastened to a vehicle,

so is the number of the postilions. The possibility of one man guiding more than one horse when attached to a travelling vehicle has not entered into the imaginations of Spanish American economists. As for the collar, it is unknown. The wild Gaucho, in fact, draws a carriage just as he would draw a wild bull — with his lazo or hunting noose attached to the right or off side of his saddle girth. The *carri-coché* consists of a close framed body, painted and lined, with sliding glasses, and a door to open behind, the whole suspended on long braces or twisted cords of untanned hide. When used in towns it is intended to be drawn by one or two horses with a postilion, and to carry six persons, three on a side like an omnibus.



BUENOS AYRES CARRI-COCHE.

The objections to this carriage are, that the body being fixed on two nearly straight braces, and having little weight to steady it, when on a rough road the quick vibrating motion is almost as unpleasant as actual concussion. In every carriage thus suspended, great weight or inertia is absolutely necessary to procure ease to the passenger.

Those who have travelled in the heavy and heavy-loaded French diligences at a slow rate, will not have found their motion unpleasant; but whoever has experienced the movement of the rude leather-covered carts formerly used for the conveyance of the French mail will never wish to repeat the experiment.

To get much ease in the mode of suspending the body or sitting part of a wheel carriage by braces stretched or attached to solid supporters, it is necessary to have great length. This of course must increase the weight, and be an additional motive for resorting to some more perfect method of avoiding concussion. This would naturally be by the interposition of positive elastic substances. Elastic wood, from its facility of workmanship, and also from general familiarity with its qualities, acquired by the long use of the bow as a projector of missiles, would be the first resorted to. Amongst the settlers of Upper Canada, and the inland portion of the United States, are to be found the rudest four-wheeled vehicles used by civilised people. They are called waggons, and consist of an oblong packing-case of rough planks, beneath which the wheels are attached, the fore wheels being contrived to turn or lock very slightly. They are used with one or two horses, whether for farm or other purposes. When used as a personal conveyance, a simple contrivance is resorted to, to lessen concussion. A kind of framed chair, affixed to two bearers of elastic wood, is placed inside for the principal sitters; and if there be others, they rough it out as they best can. These rude springs are also used in the construction of gigs, or two-wheeled vehicles drawn by one horse.

In England also, wooden springs are occasionally used for two-wheeled vehicles; when they are placed at right angles across the axle, the body resting upon them. A light four-wheeled vehicle was invented some few years back, by a Mr. Johnson. It consisted of two very long light poles, connecting the hinder axle and wheels with the fore cross bar, beneath which the under frame and fore wheels were made to turn: the seat, for a single sitter, was placed in the centre of the poles, which by their flexibility served as springs. This vehicle was very light, and not very uneasy; but, owing to its great length, it was ill adapted to turn in ordinary streets.

The long braces which supported the huge bodies of the lumbering vehicles formerly called coaches, were usually attached to a strong wooden pillar, or frame at each end, which was either upright, or slightly sloping outwards. After a time, an attempt would be made to give some flexibility to these pillars, but such an attempt would be very imperfect, as wood in short lengths cannot be made to carry heavy weights, and exhibit the quality of elasticity at the same time. The long-bow of wood is of considerable length; the cross-bow of steel is comparatively short, yet possesses more power and elasticity. These different qualities would soon be compared as applicable to carriages, and after some few preliminary experiments, upright pillars of elastic steel would form the supports for attaching the braces. They would at first be constructed of a single piece of steel in a taper form, and thence by gradations, regulated by the modes of their failure, they would assume the form of laminæ, playing one against another.

This accomplished, a carriage would possess all the essential *principles* required; viz.—facility of moving forward and facility of turning round by the application of the needful external power, and freedom from concussion to the passengers. The carriages existing at the present day in the greatest state of perfection as yet accomplished, are merely these same principles better regulated by more perfect combinations and more perfect execution.

CHAPTER I.

Early History of Wheel Carriages.—Scriptural Chariots.—Caretta, Carruca, Arcera, Lectica, Carpentum, Decemjugis.—Grecian Chariots.—Car from Persepolis.—Wine Waggon and Car from Pompeii.—Saxon MS.—Essedum.—King John's Litter.—Queen Katherine's Litter.—Chariot of Lady Ermengard.—Chariot of Meliadus.—First Suspended Carriage Hungarian.—Whirlicote.—Robert Westende.—Coach.—Kotczi.—Emperor Frederic III.'s Close Carriage.—Elector of Cologne.—Margravine John Sigismund.—Henry the Fourth of France.—Emperor Ferdinand the Second.—Coaches of Perfumed Leather.—Glass Coaches.—Emperor Leopold's Wedding Carriage.—Brouette.

Some of the earliest records of wheel carriages are to be found in the Old Testament, though, as it confines its mention of them to the simple fact of such things being in use, no light is thrown upon what was their construction. The "chariot" and the "waggon" are both named in Genesis. Joseph rode in the second chariot of Pharaoh as a mark of peculiar dignity. "Waggons" were despatched from the court of Egypt, to convey thither the wives and little ones of the family of Jacob: from this, as well as the fact of the brethren of Joseph bearing their corn away on asses, we may infer that wheel carriages, even of the lowest description, were not in general use amongst the common people at that time. Later in the Israelitish history, we hear of the trouble caused in the host of Pharaoh, in his pursuit of the Israelites towards the Red Sea,

by the wheels being detached from his chariots, so that "they drave heavily;" an impediment almost as trying to an ancient army, as the abstraction of wheels from artillery carriages would be to one of later date.* Chariots at that period, and subsequently, were used principally for war purposes, all public games, all public sports, tended to the encouragement of this, one of their master passions; and the sound of chariots and the sound of horsemen were seldom heard, but as heralds to the sound of battle. Even the chariots themselves were made to assist in the work of destruction, being armed with hooks and scythes, by which they made considerable devastation, mowing down men wherever they came in contact with them. Though the better sort of carriages were used for so mischievous a purpose, others of an inferior kind, and at a later period, were introduced among the Jews for agricultural purposes. They were principally used for thrashing out the corn, and were called carts or drags; (a method still practised in Arabia.) The word cart is most probably derived from the Latin *caretta*, a diminutive of *carrus*; and the ancient *carruca* had most probably a kindred derivation. Beckmann, in his "History of Inventions," tells us "that the earliest Roman vehicle on record was the *arcera*, of which mention was made in the Twelve Tables. It was a covered carriage, used by sick and infirm persons. It appears to have been employed earlier than the more luxurious *lectica* (litter), and by it to have been brought into disuse."

* Detaching the wheels would seem to indicate that the wheels were fast on the axle, which turned beneath the body: the axle being thrown out of the thole pins, the chariot would become a sledge.

Isaiah, when prophesying the future glory of Jerusalem, describes the faithful as coming "upon horses and in chariots, and in *litters* and upon mules." "A later invention," continues Beckman, "was the *carpentum*; the form of which may be seen on antique coins, where it is represented as a two-wheeled car, with an arched covering, which was sometimes hung with costly cloth. Still later were introduced the *carrucæ*, first mentioned by Pliny; but so little is known of them, that antiquaries are uncertain whether they had one wheel like our wheelbarrows, or (as is more probable) four wheels This much however is known, that they were richly decorated, often with solid silver curiously engraved and carved, and that senators and people of condition were carried in them. The Theodosian Code allowed them to civil and military officers as a mark of dignity; and it was considered an honour to ride in those which were remarkably high.

There is a distinguishing difference between the construction of ancient and modern carriages in one respect:—the greater proportion of the former must have been made principally for the display of muscular strength and agility in their management, rather than for the purpose of bodily ease and relaxation. Hence might have arisen the long-retained prejudice against carriages of all kinds, as tending too much to luxury and effeminacy. Carriages really deserving the name, carrying the person who placed himself within them, without requiring his constant and dexterous management of the muscles, were seldom used except at public festivals. In "Kennett's Roman Antiquities" are engravings of several cars, as they appeared when

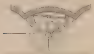
in procession to grace one of the triumphs, allowed only to dictators, consuls, or prætors. The first car contained the spoils and treasure; the second, a group of Roman nobles; and the third, the hero of the day.

The Romans had their chariot races like the Greeks; though the far-famed Olympic games carried away the prize of pre-eminence, so that the heroes of Rome were fain to enter the lists. Suetonius chronicles the Emperor Nero as engaging in the Olympic games, and riding in a *decempugis*, or chariot drawn by ten horses abreast. The renown attached to a winning chariot was as great as that now gained by a winning horse. In modern times, however, something more is contested than the reward of bare fame, and a wreath of parsley. It was remarked of Alcibiades as a thing of extraordinary extravagance, that he first sent three chariots at one time to the Olympic games. The skill in the use of these chariots must have been displayed in turning them without breaking the wheels or axles, of which there must have been some danger, as their racecourse was longitudinal instead of circular.

The earliest representations of the chariots of Greece will be found on the bas-reliefs amongst those beautiful exiles from their native land—the Elgin marbles. They were the product of the time when Pericles held sway over Athens—nearly five hundred years before Christ; and the records left on the stone tablets adorning the walls of the temples erected by him, are among the oldest handed down to us.

The vehicle here inserted is taken from an engraving of some specimens of the remaining ruins of Persepolis, de-

stroyed by Alexander the Great, three hundred and thirty years before Christ. It is from one of a number of representations of different deities typical of the seasons. This small wheel carriage served as a sort of moving platform for one of these idols, who was seated upon it in Oriental style. The mode of attaching the axle to the carriage differs from that of the Greek and Roman cars of a contemporaneous period,—or indeed from any other we have seen in antique sculpture, or elsewhere.



CAR FROM THE RUINS OF PERSEPOLIS.

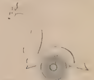
There is another, a curiosity in its way, and although of Roman origin, it differs from the usual form of cars at that time. It is from an antique gem in cornelian, which forms the subject of one of the many erudite papers in the Archæologia. It is like a Greek car reversed, and is a kind of primitive model of the whole tribe of one-horse vehicles now in use. It is drawn by horses, driven by a Cupid; but the detail of traces, harness, &c. is omitted, as is usually to be observed in representations of antique charioteering. The gem is inscribed "Marte—Mario," and has reference, in all probability, (as the historian supposes,) to some passage in the life of Caius Marius, whose for-

tunes were influenced very materially by Martha, a renowned Syrian prophetess. Marius was born one hundred and fifty years before Christ.

By far the nearest approach to the ingenuity of contrivance of modern times, is to be found in a drawing made by Sir William Gell from one of the time-defying frescos of Pompeii. It is of a wine cart, or rather waggon; and though it aided the services of the inferior orders amongst the people, it displays a neatness and ingenuity in its construction far exceeding that of the cars and ornamental vehicles of the time—supposing they had equally faithful artistical chroniclers. The four wheels are of equal size,—a desideratum long sought after for locomotive vehicles,—and the contrivance which allows them to turn with safety,—an open arched space in the centre of the cart,—is simple and practicable. The group from which it is copied is classical and elegant: the figures of the peasants employed in emptying the skins in which the wine was contained are graceful both in form and costume, the latter being the simple tunica. Sir William Gell complains of the slovenly style in which the whole is painted: his copy suggests an exquisitely neat and finished original. Notwithstanding this little discrepancy, the details as to the principle of its construction may be trusted.

In the same work are two other designs. One represents one of the several chariots drawn by different animals, which decorate the tablinum of the peristyle of the Dioscuri. It appears to be slovenly in its execution, and the details of its construction incomplete. There is an absence of elegance in its design—the angle supplying the place

of the graceful curve which characterised the Greek chariots of earlier date.—The other is from a design executed in stucco on a stone in the temple of Venus. The group entire represents Love in the act of driving two mules, though Love must have been somewhat deficient in taste to have selected such cattle for such a carriage.



CAR FROM POMPEII.

The simplest of all forms that have made pretension to the name of chariot, is the *essedum* of the ancient Briton, referred to in Cæsar's Commentaries, Lib. iv. c. 29. He there, in describing the manner in which our rude forefathers were wont to conduct themselves in battle, distinctly proves an obvious difference between the war chariot of the Briton and that of the Roman. The Britons, it appears, were accustomed to leave their chariot, and run along a pole which was attached to it, from whence, or from the yoke, they engaged the enemy, again to retire into their chariot when they saw fit. Its construction must have been low in the fore part to have allowed this; differing essentially from those of the other nations, which are thus represented: "Front of the body breast-high,

rounded like a shield, so as to answer to the driver for a defence; and was for that reason called ἀσπιδίσκη, or the shield part." Strutt, in his "Manners and Customs of England," mentions a kind of chariot in use amongst the Anglo-Saxons; he says, it is supposed to have been derived from the Britons, and to be the old British *essedum* referred to by Cæsar. Without meaning to insult the memory of our warlike ancestors, it has nevertheless a striking resemblance to the donkey carts in use in many of our country villages: but it is somewhat wanting to the religion of history thus to profane what most probably was the moving platform from whence Boadicea with her wronged daughters harangued the brave though undisciplined Icéni.

An evident improvement in invention was made by the Saxons. In the Cotton Library there is a valuable Saxon illuminated manuscript; by some supposed to be that of Ciedna, by others the work of Elfricus abbot of Malmsbury. The subject is a comment on the books of Genesis and Exodus, with illustrative delineations. In one of these may be found the first approach to a slung carriage; and it may be interesting to the lovers of historical coincidence, that it is given in an illustration of the meeting of Joseph with Jacob, of that part of the Old Testament which first makes mention of vehicular conveyance. The cpæt or chariot in which Joseph is seated is a kind of hammock, (most probably made of leather, which was much used by the Anglo-Saxons,) suspended by iron hooks from a framework of wood. It moves upon four wheels, the construction of which is somewhat ambiguous, owing to decorative

licence having been taken with them by the artist. The father of Joseph is placed in a cart, which we doubt not, from its primitive simplicity, is a faithful representative of those of the time. This proves the illuminator to have been true both to his subject and the custom of the period in which he lived, as the *equo* was monopolised by the principals, while the people rode in carts.

With the Normans came the horse litter, a native originally of Bithynia, and from thence introduced into Rome, where it is still used by the Pope on state occasions, and also among the mountain passes of Sicily—also in Spain and Portugal. Malmsbury records that the dead body of Rufus was placed upon a "*rheda caballaria*," a kind of horse litter,—or, as Fabian translates it, a "horse litter." King John, in his last illness, was conveyed from the Abbey of Swinstead in "lectica equestri." These were for several succeeding reigns, the only carriages in use for persons of distinction. Froissart writes of Isabel, the second wife of Richard II, as "La june Royne d'Angleterre en une litiere moult riche qui etoit ordonee pour elle." These litters were seldom used except on state occasions. When Margaret, daughter of Henry VII, went into Scotland, she is described as journeying on a "faire palfrey:" but after her was conveyed by two footmen, "one vary riche litere, borne by two faire coursers vary nobly drest; in the wich litere the sayd queene was borne in the intryng of the good townes, or otherwise to her good playsher." Some idea may be formed of the state and richness of these conveyances from Holinshed's description of that of Queen Katherine at her coronation:

"Then came the queen in a litere of white clothe of golde, not covered nor bailed, which was led by two palfreys clad in white damask doone to the ground, head and all, led by her footmen. Over her was borne a canopie of cloth of gold, with four gilt staves and four silver bells. For the bearing of which canopie were appointed sixteen knights, foure to bear it one space on foot, and other foure another space." Long after the introduction of coaches, the litter continued in use. In the frontispiece of Thomas Scott's "Vox Populi," (1620) there is a representation of a litter carried by mules; and the mother of Henrietta, queen of Charles I, entered London in a litter, having previously travelled from Warwick in a coach.

The feudal times were obviously unfavourable to the use of carriages; the only seat considered befitting a knight was his saddle,—and the only place for a vassal, at the stirrup of his liege lord. The knights bestrode their coursers, and fair dames gracefully reined up their richly-caparisoned palfreys. In 1239, on the entrance of Frederic II into Padua, ladies highly born and sumptuously attired came forth to meet him on horses ornamented with trappings. But this state of things was to have its change: the more commodious though less picturesque wheel carriage came to make its innocent and bloodless *revolution*.

Italy, France, Spain, and Germany take the lead of us in their records, and contend with each other for the honour of the first introduction of carriages. The earliest record we have found is upon Beckman's authority: he states, that when Charles of Anjou entered Naples, (towards the end of the thirteenth century,) his queen rode in a *caretta*, the

outside and inside of which was covered with sky-blue velvet, interspersed with golden lilies. That the example of the fair queen was speedily followed in France, though most probably at a humble distance, may be inferred from the fact of an ordinance of Philip the Fair being issued in 1294, (and which is still, according to Beckman, in preservation,) for suppressing luxury, and forbidding the citizens' wives the use of "cars." That these carettas were the same with the "cars," "chares," and latterly the "charat," in form, though differing in adornment, there is little doubt; and although "caretta," and "sky-blue velvet," and "golden lilies," seem far more fitting to describe the car of Cinderella, or of some radiant genius in a fairy pageant, there is little difficulty in believing that all the above-named vehicles had one universal family likeness, both in name and construction, to our common broad-wheeled cart! In the "Anciennes Chroniques de Flandres," date 1347, a manuscript in beautiful preservation,—a work of art it may be called, from the brilliancy and delicacy of its finish,—is an illustration of the flight of Emergard, wife of Salvard, Lord of Rousillon. The carriage in which she is seated, is not only richly coloured, but the details of its construction are accurately supplied. The outer edges of the wheels are coloured grey, to represent a tire of iron, and the horses are attached to the carriage by a similar method to one now in use. The body of the cart or "chariette" is of carved wood, and the hangings of purple and crimson, turned up in the centre. The Lady Emergard is seated inside, with an attendant behind, and

her Fool in front. The machine is drawn by two horses, the charioteer sitting upon the left horse.

That England was not far behind in the possession of the "chare," we have testimony, and that of an interesting kind, as it has thrown some light upon a part of the Lady Emergard's vehicle of stately clumsiness of which we had not till then discerned the use. In "The Squyr of Low Degree," supposed to be before the time of Chaucer, (vide Ellis's Specimens of Early English Poetry,) the father of the Princess of Hungary thus makes promise :—

> "To-morrow ye shall on hunting fare,
> And ride my daughter in a *chare*.
> It shall be covered with velvet red,
> And cloths of fine gold all about your head;
> With damask white, and azure blue,
> Well diapered with lilies new:
> Your pomelles shall be ended with gold,
> Your chains enamelled many a fold."

These pomelles* were doubtless the handles to the rods affixed towards the roof of the "chariette;" and were for the purpose of holding by, when deep ruts or obstacles in the road caused an unusual jerk in the vehicle:—in the illumination they are gilded. This coincidence with the other of the "lilies" in the "caretta," seems to identify the carriages as far as general construction is concerned.

That the use of wheel carriages became common in

* Pomelle—probably a diminution of *pomme*, little apple — referring to the small round knob by which the hand held on. Modern carriages still retain a similar appliance in the shape of inside lace-holders, even now that the improvements in springs and roads have rendered them useless except as ornaments.

England as they did in France, may be gained, amongst others, from Froissart, who, in speaking of the return of the English from Scotland in the reign of Edward III, tells of "leurs charettes," which were most likely of a similar form to those above mentioned; though, as they were used for purposes of war, they were without any of the elegant appurtenances that were thought seemly for ladies of high degree.

The progress of improvement in vehicular locomotion appears to have been very slow. A double reason may be found for this: an internally struggling country has little time or means to foster inventive power, and the bad state of the roads, which continued for centuries, make it no marvel that a machine nearly akin to a broad wheeled waggon, was the only carriage employed by people of condition in our early history. In France progress was almost equally slow. In "Le Roman du Roy Meliadus," a manuscript which is supposed to bear date towards the middle of the fourteenth century, a representation is given of the carriage which had the honour of conveying his majesty, which, with all the added charm a poetical imagination has given to it in a wheel of architectural design, has yet in the body of the carriage a most unfortunate plebeian likeness to one of our common vans. Another reason may be found for this backwardness in improvement, in the strong prejudice which existed against the use of any kind of carriage ministering to personal indolence. It was thought derogatory to the dignity of men to be seen in them: princes and electors who have avoided attendance on the meetings of the States, have excused themselves on

the plea of the unfitness of their health to bear the fatigue of a long journey on horseback. In the "Mémoires sur l'Ancienne Chevalerie" of M. of Sainte Palaye, he mentions the entrance into Bruxelles of Louis the Dauphin in 1456 on horseback, and that he was met at the *porte* by the Duchess Isabella and other ladies of the court on foot!

One of the most curious documents relative to this time, is to be found in Roubo's "L'Art de Menuisier." It has reference to the introduction of what would seem to us to be the first suspended carriage, although history ascribes this to a much later date. In speaking of a carriage brought from the King of Hungary as a present to the Queen of Bohemia, and which seemed to excite the wonder and admiration of the good Parisians, he describes it as "*branlant* et moult riche." What could *branlant* (quivering or trembling) mean, but that it swayed to and fro, from being suspended? From this time covered carriages began to be used in France, though somewhat sparingly. They were forbidden for common use, even to women, as tending too much to the promotion of luxury; and only those of the highest rank were permitted to use them. At all public ceremonies there is no mention made of state coaches, but of state horses and state mules. Even his holiness the Pope rode upon a grey horse; though, to indemnify him for the exertion, his horse was led and his stirrup held by kings and emperors.

As time went on, people became more philosophical; and one evidence of this was, in preferring the ease that does no injury, to the self-denial that does no good;—or

rather, the case that does good, to the self denial that does injury. Covered carriages began to obtain more commonly, though at first their uses were confined to long journeys or times of public ceremony. Hungary appears to have been the country out of which the coach was born, though many nations contend for the honour of fathering the unwieldy child, which has in its turn been father to a numerous tribe of now rapidly-improving offspring. Denma contends for Spain, Father Semedi, for Italy; the "Encyclopedie Française," for France; while we would put in a claim founded on the "whirlecote," which conveyed the mother of Richard II. from the terrors of Wat Tyler's mob. What these whirlecotes were, we have not been able to discover, most probably the first rude attempt at the close carriage of a later period.* That the common people of this country had at this time their conveyances, may be inferred from the record of the bearing of King Richard's corpse,—"upon a chariette or sort of litter on wheels, such as is used by citizen's wives who were not able or not allowed to keep ordinary litters." Anne, the wife of this king, granted an annual stipend during the life of Robert Westende, "purvoiour de noz charlettes."

There are various and ingenious derivations ascribed to the word "coach;" some of them of an amusing character, such as, for instance, that of Menage, who says it is to be taken from the Latin *vehiculum*!—a somewhat more probable one of Junius, ὀχέω, to carry; Wachter, from the German *kutten*, to cover; Lye, from the Belgic *koetsen*, to lie along,—or, as it properly signifies, a couch or chair.

* Query—Whirling cot, or moving house.

Others have endeavoured to prove its derivation from the Hungarian,—that it had its rise in a village in the province of Wiesellung, formerly called *Kotsee*. In "Beckman's History of Inventions," (a book that has furnished us with many details and much valuable general information,) an extract is made from Stephanus Broderithus, who says, speaking of the year 1526, "When the archbishop received certain intelligence that the Turks had entered Hungary, not contented with informing the king by letter, he speedily got into one of those light carriages of the place, they call *kotcze* and hastened to his majesty." This evidence, backed by the presentation carriage before mentioned to the Queen of Bohemia, is certainly in favour of the Hungarian coachmakers; but we must leave to wiser heads to determine the exact truth: for what with the *caroche* of France, the *carocc* of Italy, the *carri-coché* of Spain, and even our own coach, the head is somewhat bewildered and is fain to take refuge in the simple *carruca* of old Rome, from which these appellations most probably had their rise. After all, it must be a divided honour. The *carетta*, *chare*, *car*, *charat*, &c. being the earlier construction, they had the earlier derivation; later came the Hungarian *kotcze*, the German *kutsche*, &c. &c., and adding both form and name to what had gone before, produced a mixed vehicle with a mixed appellation. We will glance over the state and increase of carriages on the Continent during the fifteenth, sixteenth, and seventeenth centuries, and

Query.—Are coach and couch synonymes? The earliest coaches or litters were for reclining. The cars in the procession of Maximilian are literally couches or sofas on wheels.

devote the concluding chapter exclusively to those of England during the same period and up to the present time.

In 1474 the Emperor Frederic III. came to Frankfort in a close carriage; and as he remained in it on account of the wetness of the weather, the inhabitants had no occasion to support the canopy over his head, except on going and returning from the council house—(vide Beckman). The poor citizens must have invoked as ardent a benediction on the head of him who invented coaches, as did Sancho Panza on him who "invented sleep."

At the beginning of the sixteenth century, the richness and number of carriages increased—though the accession was chiefly confined to Germany. At tournaments they were made objects for display; they are spoken of as being gilded all over, and the hangings of crimson satin. Electresses and duchesses were seldom seen without them; and there was as much rivalry in their days of public exhibition, as there is now amongst the aspirants of fashion in their well-appointed equipages at a queen's drawing-room. While in 1562 the Elector of Bologne had twelve carriages in his suite, and somewhat later the Margravine John Sigismund, thirty-six coaches, with six horses each, at Paris in 1550, during the reign of Francis I. there were but three,—one belonging to the queen, another to the king's queen, and the third to a corpulent old lord, whose inability to take exercise in any other way, rendered this luxury a necessity. If, as historians say, in spite of the "branlant" before mentioned in Roubo's comment on the carriage of the Queen of Bohemia, the carriages of this

time were not suspended, his lordship's exercise must have tended somewhat to his reduction.

Even so late as Henri Quatre little advance had been made in emulation of the more luxurious Germans. It appears from a letter said to be still in preservation, that Henry the Great had but one carriage for himself and his queen: he says, "I cannot come to you to-day, because my wife is using my coach." This coach was probably the one in which he was afterwards assassinated. It is said, that immediately upon the murder, his friends about him let fall the curtains of the coach and drove to the palace. Carriages at this time used in France were made with a canopy supported by ornamental pillars, and the whole surrounded by curtains of stuff or leather, which might be drawn up or let down at pleasure.

The example of the German nobles was soon followed by their vassals. In 1588, an edict was issued by Duke Julius of Brunswick, in which his vassals were forbidden to ride in carriages: amongst other things, he says, "that the useful discipline and skill in riding have been almost lost, and that the principal cause of this is, that our vassals, servants, and kinsmen without distinction, young and old, have dared to give themselves up to indolence, and to *riding in coaches*," &c.

The seventeenth century in Germany began with equal state in its princes, and the same imitation at a humble distance by its vassals. Count Kevenhuller, in speaking of the marriage of the Emperor Ferdinand II. with a princess of Bavaria, says, "the bride rode with her sisters in a splendid carriage studded with gold; her maids of honour,

in carriages hung with black satin; and the rest of the ladies, in neat leather carriages." At the same time an attempt was again made to suppress the use of carriages amongst the people. In 1668, Philip Duke of Pomerania Stetten reminded his vassals that they ought not to make so much use of carriages as of horses; and there is a less gentle admonition in the Churmark Archives, where an edict is still preserved that went to forbid the use of coaches under pain of incurring the punishment of felony. All these prohibitions were of little avail, especially as the example of the nobles tended to the increase rather than the diminution of state in their wheel carriages. Coaches of "perfumed leather" (probably what we now call Russia leather) and *glass* carriages now are mentioned.

In 1631, Mary, Infanta of Spain, rode in Carinthia in a glass carriage in which no more than two persons could sit. The wedding carriage of the first wife of the Emperor Leopold, (1658,) who was also a Spanish princess, cost, together with the harness, 38,000 florins: the carriages of the Emperor himself are thus described by Kink: "In the imperial coaches no great magnificence was to be seen; they were covered over with red cloth and black nails. The harness was black, and in the whole work there was no gold. The panels were of glass, and on this account they were called the imperial glass coaches. On festivals the harness was ornamented with silk fringe. The imperial coaches were distinguished by their having leathern traces; but the ladies of the imperial suite were obliged to be contented with carriages the traces of which were made of ropes."

From the circumstances of the two Spanish princesses being so richly appointed in their equipages, it would seem that Spain was now taking the lead which had so long been engrossed by Germany. Poor France still continued at a distance, as may be inferred from the fact, that as late as the reign of Louis XIII, (1620,) a woman was accustomed to go to court masked and hooded, jogging behind a man on horseback! The first attempt at a common usage of covered wheel carriages amongst the Parisian citizens occurred at this time, in the introduction of a vehicle called *brouette* or *roulette*. The body of this was like a sedan chair, placed upon two wheels, and was dragged by men. The proprietors of sedans interfered to have them prohibited; just as our short-sighted labourers would proscribe machinery, not seeing how much in the end their own toil may be mitigated. For a while they were forbidden, but were permitted in 1669, and in 1671 they were in general usage amongst the people. Dupin, the inventor of these *brouettes*, found means to contrive them so that their motion was tolerably easy; and his ingenuity concealed his art so well,—or rather, the Parisian mechanics of that time had so little of enterprise or curiosity,—that he was the only one who made them. The author has obtained from Roubo's "L'Art de Menuisier," in the Bibliothèque Royale at Paris, the mode of the suspension of these carriages, which, as they were the only ones of the time, and are the earliest of the kind on record, are a mechanical curiosity. The description is here inserted in its original quaint French, with the accompanying illustrations.

"Les brouettes sont des petites voitures assez semblables aux chaises à porteurs pour ce qui est de la forme et la construction de la caisse, mais elles diffèrent de ces dernières, en ce qu'elles sont portées par des roues, ou, pour mieux dire, par un ressort [possibly of elastic rope] attaché au corps de la voiture et à l'essieu des roues, et traînées par un homme au moyen de deux batons attachés à la voiture, entre lesquels il est placé comme un cheval de limon, ce qui, malgré l'usage, ne fut pas beaucoup d'honneur à l'urbanité française. Toute la différence qu'il y a entre le corps d'une chaise à porteurs et celui d'une brouette, c'est qu'à ce dernier il faut placer deux montants sur le derrière dans la partie de l'appui, ou, pour mieux dire, un seul montant évuidé au milieu pour passer l'essieu des roues et les montants, qu'ils le soient de manière que les roues ne débordent pas le corps de la voiture peu devant, et que leurs ouvertures, ainsi que le siège, soient assez élevés pour que l'essieu puisse monter sans y toucher. Les roues des brouettes ne sauroient avoir plus de 3 pieds 8 pouces de diamètre, parce que si elles en avoient davantage, elles hausseroient trop le siège, qui est déjà fort élevé, puisqu'il a près de 16 pouces du dessous, ainsi qu'on peut le voir fig. 3, laquelle représente la coupe de la brouette, dont les élévations de face et de côté sont représentées fig. 1 et 2.

"Quant à la manière dont les brouettes sont suspendues, elle est fort ingénieuse. Elle consiste en un lien de ressort attaché en dessous du brancard, que l'on prolonge d'environ un pied plus que le devant de la voiture; le petit bout de ce ressort entre dans une boucle formée à une tringle de fer attachée avec l'essieu de sorte que tout le poids de la voiture porte sur le ressort, et par conséquence sur les roues par le moyen de la tringle montante, qui alors fait l'office de soupente. Je ne donnerai pas d'autres détails touchant la manière de suspendre les brouettes, parce que cela n'est pas du ressort de cet ouvrage, et que c'est l'affaire du serrurier de voitures, m'étant contenté d'avoir représenté dans les fig. 4, 5, 6, l'élévation d'un montant de brouette avec sa garniture de fer, et le montant de fer dans lequel passe l'essieu A, le bout inférieur de ce même montant, avec la boucle ou chape, qui reçoit le bout du ressort, et le plan des montants des côtés de la brouette, avec les garnitures de fer, dans lesquelles est pratiquée la coulisse par où passe le montant de fer, dont le collet est indiqué par des lignes ponctuées descendantes de l'élévation fig. 4, au plan fig. 6.

"Les brouettes sont peu susceptibles de décoration, étant la plupart des voitures publiques, il suffit qu'elles soient construites solidement. Cependant, comme il y a quelques particuliers qui en font usage, on

pourra faire ces dernières un peu plus riches que les autres, comme je l'ai observé au fig. 1 et 2, en j'ai mis des glaces de custode et des montants de crosses, ce qu'on ne fait pas aux brouettes publiques, lesquelles, ainsi que les chaises à porteurs de cette espèce, n'ont pas la face ainsi que par les côtés, que des ouvertures d'environ 8 ou 9 pouces de haut ouvrantes à coulisse horizontales par les côtés seulement. Les brouettes, ainsi que les chaises à porteurs publiques, doivent être un peu plus petites que celle dont je viens de faire la description, d'environ 3 ou 4 pouces sur la hauteur, afin de les rendre un peu plus légères."

BROUETTE.

In the following reign, that of Louis XIV, carriages suspended by leathern straps were supposed to be first introduced. There is a drawing in the Bibliothèque Royale of the King's entry into Paris, in which this method is adopted. But already are exceeded the limits devoted to our Continental neighbours, and it is time to return to England, beginning with the commencement of a new chapter.

CHAPTER II.

English Carriages.—Walter Rippon.—First Coach.—Queen Mary. Earl of Arundel.—William Boonen.—Queen Elizabeth's Coach.—Cost of a Coach.—M. de Rosny, Treasurer of France.—Scotch Patent for Public Carriages.—Strictures on Coaches by Taylor the Water Poet.—Colloquy between Coach and Sedan.—Dialogue between a Frenchman and a Londoner.—Public Travelling.

THE introduction of coaches into England appears to have been at a somewhat later period than either in France or Spain. In Stowe's "Summarie of the English Chronicle," he says, coaches were not used till the year 1555, when Walter Rippon made a coach for the Earl of Rutland, which was the first ever made in England; and in the year 1564, the same Walter made the first "hollow turning coach," with pillars and arches, for her majesty, (Queen Mary), being then her servant; and in the year 1584, he made "a chariot throne with foure pillars behind, to beare a crowne imperiale on the toppe, and before two lower pillars, whereon stood a lion and a dragon, the supporters of the arms of England." Another ascribes their introduction to Fitzallen Earl of Arundel, who brought one from Germany in 1580. In the postscript to the Life of Thomas Parr, written by Taylor the Water Poet, (and a mortal enemy to land carriages,) we find the following

note: "He (Parr) was 81 years old before there was any coach in England, (Parr was born in Edward IVth's reign, 1483;) for the first ever seen here was brought out of the Netherlands by one William Boonen, a Dutchman, who gave a coach to Queen Elizabeth, for she had been seven years a queen before she had any coach; since when they have increased with a mischief and ruined all the best housekeeping, to the undoing of the watermen, by the multitudes of hackney-coaches. But they never swarmed so much to pester the streets as they do now, till the year 1605; and then was the gunpowder treason hatched, and at that time did the coaches breed and multiply." Taylor is to be thanked, not only for his information, but for his capital though unconscious burlesque upon those fancied philosophers who talk of cause and effect, where events, because they happen in sequence, are made to depend one on the other, when the fact of their being two things apart makes them independent existences. Another absurdity may be noticed: the attempt then, as too often now, to sacrifice newly-increasing comfort to old custom—the multitude of coaches to the lesser number of watermen. What would the murmurer have said now to the moving mass of omnibuses and other conveyances that stretch from one end of Babylon the Greater to the other? What would he say an hundred years hence, when owing to the superior compactness and cheapness of their construction and manufacture, their number will perhaps be trebled?

The moving temple before described as made for Queen Elizabeth was doubtless suggested by the importation of the Dutchman, and in process of time gave rise to the

more easy but less magnificent coach of modern use. To have attached a "box" to a "moving temple," would have been a most derogatory anomaly; so "the coachman joined a horse found to match a saddle-horse to the coach-tree, then he sitteth upon the saddle, and when there was foure horses, he drave those which went before him, guiding them with a reign." That the carriages used by Queen Elizabeth could be opened and closed at pleasure, may be inferred, from her causing at Warwick, during one of her progresses, "every part and side of her coach to be opened, that all her subjects present might behold her, which most gladly they desired."

We now find conveyances of numerous kinds becoming general amongst the wealthier people. Spenser, in his "Faery Queen," uses the words "wagon," "coche," and "charat." Long waggons for passengers and goods, afterwards called caravans, were introduced, though of somewhat clumsy construction to accommodate them to the baduess of the roads and the number of persons they carried. Private families had their private carriages. in the year 1573, there is in the household book of the Kytson family, (vide the Archælogia, vol. xx.) a memorandum of the cost of a coach then in use; it runs thus:—"1573. For my m^res coche, with all the furniture thereto belonging except horses—xxxiiij *li.* xiiij s. For the painting of my m^r and my m^res armes upon the coche —ij *s.* vj *d.*"

"For y^e coche horses bought by M^r Paxton—xj *li.* xiii *s.* iii *d.*"

At the close of the following century is another minute

of a similar kind, entered in Sir William Dugdale's diary.

"1681. Payd to Mr Meares, a coachmaker in St. Martin's Lane, for a little chariot wch I then sent into the country, £23. 15s. 0d.; and for a cover of canvas, £01 00s. 00d.; also for harness for two horses £04. 00s. 00d."

Vehicles of all descriptions now became general, and an outcry was speedily raised against them. In 1584, William Lilly, in one of his plays, complains of those who were accustomed to go to a battle-field "on hard-trotting horses, now riding in easie coaches up and down to court ladies." So high did the clamour run, that a parliamentary bill was in agitation to prevent the increase of coaches; its alleged necessity being, that government would be at a loss to mount the army, owing to the increased use of horses amongst the common people.

Meantime England was lending in turn to other countries what she herself had borrowed. Towards the end of the sixteenth century, John of Finland, on his return from England, among other articles of luxury took with him to Sweden the first coach that was seen in that country. Before that time, the nobles of Sweden when they travelled carried their wives behind them on horseback. The princesses travelled in like manner, and when it rained, enveloped themselves in a mantle of waxed cloth.

In 1598 it was accounted a great marvel that the English ambassador to Scotland had a coach with him, as it was the custom for all public functionaries to add to their other toils of office that of making long journeys on horseback. James I. made his first progress from Edin-

burgh to London after this fashion. Stowe records his leaving Edinburgh on the 5th of April, and not reaching London till the 7th of May. We must cease to wonder at slow national progression, if all public business was conducted at a similar rate. Great part of the way where the country was favourable, the king hunted; and on the day of his arrival, to avoid the extremity of dust, he rode from Theobaldes, through the meadows. At Stamford Hill he was met by the lord mayor, knights, and aldermen of London, in scarlet robes, all on horseback, and "multitudes of people swarming in highways, in fields, on houses and trees, to behold the king, and with whom the name of king was very strange, being full fifty years since there was a *king* in England."

There is a record by the same chronicler of the common use of carriages at this period. "On the 8th of June following arrived at London, Monsieur de Rosny, great treasurer of France, accompanied with noblemen and gentlemen in great number. The same night they, *in thirty* coaches, rode to the French ambassador's leaguer, then lodged at the Barbican by Redcross Street." Anderson places the period of the general employment of coaches in 1705, and, in his "History of Commerce," gives the following state of the number and increase of hackney-coaches in London and Westminster:

In 1637	. . .	50
1652	. .	200
1694,	limited to .	700
1716	. .	800.

This does not quite agree with Old Parr's chronicler, who

surely could not account fifty coaches in London a swarm sufficient to ruin the watermen or cause the gunpowder plot! What would he say now to the nine hundred omnibusses of modern growth, exclusive of the ancient-looking hackney coaches, and the endless varieties of the great mushroom family of cabs.

It is a singular fact that in the earlier use of coaches in Scotland, that country was indebted to a native of Stralsund, in Pomerania, who, in the year 1610, offered to contract for a certain number of coaches and waggons, with horses to draw and servants to attend them. Accordingly, a royal patent was granted him, conferring an exclusive privilege, for fifteen years, of running between Edinburgh and Leith. In England, coaches were daily becoming more necessary to the good citizens; although, in many quarters, the prejudice ran high against their use. The most vehement outcries, as might be expected, were to be found amongst the watermen, whose "rights" were most infringed upon. These, with their own poet Taylor at their head, now and then assisted by a stray pamphleteer or squib-writer, raised so formidable a complaint, that the matter was taken into parliamentary consideration, and there was some serious discussion as to the eligibility of checking the too frequent use of hired coaches! The supposed necessity of such an injunction is almost to be wondered at when we consider what these vehicles were—without springs, and altogether clumsy and unsightly in their construction—vehicles in which people were, in the words of Taylor, "tost, tumbled, rumbled, and jumbled without mercy." Take his more elaborate description:

"The coach is a close hypocrite; for it hath a cover for knavery, and curtains to vaile and shadow any wickedness. Besides, like a perpetual cheater, it wears two bootes and no spurs, sometime having two pair of legs to one boot, and oftentimes (against nature) it makes faire ladies weare the boote; and if you note, they are carried back to back, like people surprized by pyrats, to be tyed in that miserable manner and thrown overboard into the sea. Moreover, it makes people imitate sea-crabs, in being drawn sideway as they are when they sit in the boot of the coach; and it is a dangerous kinde of carriage for the commonwealth, if it be considered." He even ventures so far in his abuse as to call them "hell-carts,"—a nickname which they retained for many years after. In 1635, a patent was granted to Sir Saunders Duncombe for the introduction of sedans; their purpose being "to interfere with the too frequent use of coaches, to the hindrance of the carts and carriages employed in the necessary provision of the city and suburbs." A rivalry now sprang up between coach and sedan; and it gave rise to a humorous tract, in which they are impersonated, and represented as holding a colloquy. From the different descriptions, as well as the plates given of them, we may form some idea of their construction at that time. The title runs thus—(we quote from the Archælogia)—"Coach and Sedan, a pleasant dispute for precedence, the brewer's cart being moderator:" 1636. They are thus described: "The one (sedan) was in a suite of green, after a strange manner, windowed behind and before with isinglasse (talc), having two handsome fellows in green coats attending him, the one ever

went before, the other came behind. Their coats were laced downe the back with a green lace suitable; so were their half-sleeves; which persuaded me at first they were some cast sutes of their masters. Their backs were harnessed with leather angles cut out of a hide as broad as Dutch collops of bacon." — "The other (Coach) was a thick, burly, square-sett fellow, in a doublet of black leather, brasse buttoned downe the breast, back, sleeves and wings, with monstrous wide bootes fringed at the top with a net fringe, and a round breech guilded, and on the back an achievement of sundry coats in their proper colours, &c. &c. Hee had only one man before him, wrapt in a red cloake, with wide sleeves turned up at the hands, and cudgelled thick on the back and shoulders with broad shining lace (not much unlike that which mummers make of strawen hats), and of each side of him went a lacquey, the one a French boy, the other Irish, both suitable alike." During the argument "Coach" has somewhat the worst of it. Sedan speaks:—"And, Coach, twice or thrice a year, you must needs take a voyage to London with your ladie, under a collar, to be new collored, guilded, or painted, covered, seated, shod, or the like; when her errand indeed is, as one saith well, speaking to such ladies who love to visit the city,

> "To see what fashion most is in request,—
> How is this countess, that court ladie drest.

Hence it happens, Coach, that by your often ambling to London, Sir Thomas or Sir John sinks, as in a quicksand, by degrees so deep into the merchant, mercer, or lawyer's booke, that hee is up to the eares, ere hee be aware;

neither can he be well drawne out without a teame of usurers, and a craftie scrivener to be the fore-horse, or the present sale of some land; so that wise men suppose this to be one maine and principal reason why within a coach journey of a day or two from the citie, so many faire inheritances as have been purchased by lord mayors, aldermen, merchants, and other rich citizens, have not continued in a name to the third, yea, scarce the second generation; when, go far north or westward, you shall find many families and names of nobilitie and gentrie to have continued their estates two and three hundred years, and these in a direct succession." The moderator "Beere-cart" seems an apt disciple of the lawyer who made the celebrated oyster decision, for he thus finishes the dispute: "Coach and Sedan, you both shall reverence and ever give way to Beere-cart wherever you shall meete him, either in citie or countrie, as your auncient and elder brother."

In the first day's entertainment at Rutland House, (vide Sir William D'Avenant's Works,) this despotism of Beere-cart is appealed against in a disputation between a Parisian and a Londoner, who contend for the superiority of their national cities. We give the extract; and it seems to imply the superiority at that time of the coaches of Paris to those of London, as the Frenchman remains unanswered. "The song being ended, a consort of instrumental music after the French composition being heard awhile, the curtains are suddenly opened, and in the rostras appear sitting a Parisian and a Londoner in the livery robes of both cities, who declare concerning the pre-eminence of Paris and London." The opening ad-

dress of the former deserves quotation. "You of this noble citie are yet to become more noble by your candor to the plea between me, a bourgeois of Paris, and my opponent of London; being concerned in honour to lend your attention as favourably to a stranger as to your native oratour; since 'tis the greatest signe of a narrow education to permit the borders of rivers or strands of seas to separate the general consanguinity of mankinde: though the unquiet nature of man (still hoping to shake off distant power, and the incapacity of any one to sway universal empire) hath made them bounds to divide government. But already I think it necessary to cease persuading you, who will ever deserve to be my judges, and therefore mean to apply myself in admonishing him who is pleased to be awhile my adversary." He does admonish him, and very wisely too, on his national conceit, on his imperfect system of education, and other subjects of different import to the one directly before the reader. After some remarks on the overhanging build of the city, contrived, he supposes, "in the days of wheelbarrows, before those greater engines, carts, were invented," or as "an umbrella of tiles to intercept the sun," or that "the shambles were so empty that fresh air was to be avoided least it should sharpen the appetite," he continues—"I have now left your houses, and am passing through your streets; but not in a coach, for they are uneasily hung, and so narrow that I took them for sedans upon wheels. Nor is it safe for a stranger to use them till the quarrel be decided, whether six of your nobles sitting together shall stop and give place to so many barrels of beere. Your city is the

only metropolis in Europe where there is a wonderful dignity belonging to carts. Master Londoner, be not too hot against coaches; take advice from one that eats much sorrel with his broth."

The fever against the use of coaches—nay, against coaches themselves, (vide Bishop Hall, who calls them "sin-guilty,") continued to rage, the watermen turning firemen on their jury, and others, with less interested motives, but with equal absence of reason, crying out for their suppression. "Coaches and sedans, (quoth the waterman,) they deserve both to be thrown into the Thames; and, but for stopping the channell, I would they were, for I am sure, [now comes the gist of this and many a modern objection,] where I was wont to have eight or ten fares in a morning, I now scarce get two the whole day!"

At this period, it may be presumed, public vehicles were universally used, not only for short distances, but for long journeys. For proof we are again indebted to the Archæologia, which gives the following letter, date 1673, with an authenticated pedigree:—"Honored Father, my dutie premised, &c I got to London on Saturday last. My journey was noe ways pleasant, being forced to ride in the boote all the way. Ye company yt came up with mee were persons of great quality, as knights and ladies. My journey's expense was 30s. This travel hath soe indisposed mee, yt I am resolved never to ride up again in ye coatch," &c. Directed—"To his honoured Father, Parkins, Esq. Browsholme House. To be left with the postmaster, Preston, Lancashire."

It may be inferred from the foregoing extract that

the journey from Lancashire required some days for its performance; but even this rate of travelling had its impeders amongst the objectives. The writer of a tract in the Harleian Miscellany (1673) deprecates "the multitude of stage-coaches and carriages now travelling on the roads," and advises parliament to interfere to suppress them; — "especially those within fifty or sixty miles of London." He recommends the others being obliged to travel with one set of horses, and to be limited to thirty miles in summer, and twenty-five in winter, *per diem!* Although the legislature was too wise to adopt the recommendation of this "slow coach," locomotive conveyance made for some time only a tortoise-like progression. So formidable an affair was the undertaking a journey reckoned, that even from Birmingham to London a departure was the signal for making a will, followed by a solemn farewell of wife, children, and household! Slow travelling, and a correspondent tardiness of other arrangements, continued to a much later period than might be imagined, when we look, not at the rapid rate at which journeys are made from place to place, but even as we write, we are conscious that those who come after us will be tempted to smile at our "rapid rate," as we have often smiled at the rapid rate of our grandfathers, in their advertisement of "that remarkable swift travelling coach the Fly, which leaves Birmingham on Mondays and reaches London on the Thursday following." When we consider that the days of railroads are in their infancy, and yet what extraordinary progress is made through their agency, we can scarcely calculate on what their capability, com-

bined with that of steam, or other yet undiscovered means of employing the powers of nature, may effect.

Toward the end of the seventeenth century, improvements began to take place. In Wood's Diary, mention is made of a machine called the "Flying Coach," which completed the journey between Oxford and London in thirteen hours! The outcry lessened, and the imperfect vehicles and bad roads were left to passengers unmolested. What the latter were, may be imagined from the fact, that when Charles III. of Spain visited England, and Prince George of Denmark went out to meet him, both princes were so impeded by the badness of the roads, that their carriages were obliged to be borne on the shoulders of the peasantry, and they were six hours in performing the last nine miles of their journey!

Abroad, little progress seems to have been made. In a curious collection at St. Petersburg, now in the possession of the Emperor Nicholas, and originally belonging to Peter the Great (recognised as Emperor in 1725), some specimens of antique carriages are still preserved. One is close, made of deal, stained black, mounted on four wheels, the windows of mica instead of glass, and the frames of common tin: the other is open, with a small machine behind of the shipwright emperor's invention—its purpose to determine the number of miles traversed on a journey. In the same collection is the litter of Charles XII. used at the battle of Pultowa.

During the eighteenth century, improvements were very gradually made in carriages, and but little progress in the rate of travelling. So late as 1760, a journey from Edin-

burgh to London occupied the time of eighteen days,—a part of the roads being only accessible by pack-horses. Within our own time may be remembered the uncouth "turns-out," as a coachman would emphatically call them, both in private and public conveyances:—heavy coaches, laden with ill-packed luggage; miserable horses, bound in worse harness, all at the mercy of a red-faced, half-drunken apoplectic coachman, with a wisp of straw for a hatband, and buried under a weight of dirty drab capes and cotton neckcloths, looking as if he united the double capacity of driver and passenger, sufficient weight for the coach, being the passenger thereon.

CHAPTER III.

Definition of Wheel Carriages. Primary and Secondary.—Animal and Elemental Power. Elasticity and Gravity. Examples.—Mechanical Powers. Lever. Wheel and Axis.—Pulley.—Inclined Plane. Wedge.—Screw. Muscular Action.—Hydrostatical Action. Automatical Action. Ponderatical Action.—Geometrical Forms in Carriages.

A WHEEL CARRIAGE moved by internal action, as when steam power is combined with it, may be defined—a primary machine for the purpose of locomotion.

A wheel carriage moved by external action may be defined—a secondary machine for the purpose of locomotion.

A machine, properly so called, is a material combination of two or more of the means designated by mechanicians as "mechanical powers," whereby the forces known as animal and elemental* power may be transmitted to other bodies with various modifications, for the purpose of producing motion in them.

Animal and elemental power may be divided into two classes: that which acts by the force of elasticity, and that which acts by the force of gravity.

* The author has retained this old term on account of its familiarity to the general reader, though savouring of the quaintnesses of the antique chemistry, now exploded.

When a horse is used for the purposes of draught, part of his power consists in the elastic action of his muscles, which serve to throw his body forward, as when he first bends and then straightens his limbs; and part of it in gravity, as when he hangs his body forward against the traces after the expansive muscular action is expended. For this reason a heavy horse can do more work than a light one, with less fatigue, even though the muscular action of both be of equal power.

When a man works the wheel of a tread-mill by climbing from step to step, it is the force of gravity alone which acts directly. The elasticity of his muscles only serves to enable him to maintain a position in which his gravity can be available to produce motion.

When a man lifts a weight from the ground in a vertical position, it is the force of elasticity alone which acts; viz. the expansion and contraction of his muscles: the weight of his body does not enter into the account as a producer of motion. A man whose muscles possess great power of expansion and contraction will exert more force than a much heavier man whose muscles do not possess the same power.

But when a man pulls a rope above his head without his feet being fastened to the surface on which he stands, the elasticity of his muscles only serves to secure his gripe on the rope: all the motion he can give it is the effect of the gravity of his body,—so that a heavy man will exert more force than a light one.

Amongst elemental powers, steam may be considered as

an example of pure elasticity. This power is used in numberless modes as a first mover.

Atmospheric air, on the contrary, possesses the powers both of elasticity and gravity. The former is shown in its action in the form of wind upon mills, and also in its compressibility; the latter, by its downward action in the piston of an atmospheric steam-engine, when the steam which served by its elastic force to raise the piston has been again condensed and restored to the state of water.

The water of running streams, which is applied to turn mill-wheels, is an example of the force of pure gravity. The tidal power of the ocean is precisely the same, when applied to mill-wheels.

As the elastic force of gases has not yet been efficiently applied to produce motion, they may be omitted. The classification, then, of the available "powers" will be as follows:

Animal Power.
Wind Power.
Water Power.
Steam Power.

The two kinds of force by which the powers are made available to perform human drudgery, viz. elasticity and gravity, may be considered as primary and secondary; for in no case can gravity produce motion until it has been acted on or disturbed by elasticity. Thus, the horse's weight or gravity in draught is not brought into action until the elasticity of the muscles has thrown the centre over the base. The gravity of the man on the tread-wheel does not act till the elasticity of his muscles has raised him

the necessary height. The man who pulls the rope cannot bring his gravity to act, till the elasticity of his muscles has raised him from the ground, and served to suspend him from the rope. The weight of the atmospheric air cannot drive down the piston of the steam engine till the elastic action of the vapour has first raised it. The water of the running stream cannot bring its gravity to bear on the mill wheel, till it has been first raised from the surface of the ocean to the summit level of the fountain head, in the form of elastic vapour.

Therefore, the material source of all physical power may be considered to reside in the principle of elasticity; and the secondary means of distributing this power consist in certain natural forms of matter which man has imitated, and which mechanicians have agreed to designate as mechanical powers, but which, it is evident, are not powers in themselves, but merely vehicles or instruments for the transmission of power, just as a steam engine is a vehicle for the employment of steam power or the force of steam.

The mechanical powers, as set forth by mechanicians, are six in number:

The Lever,
The Wheel and Axis,
The Pulley,
The Inclined Plane,
The Wedge,
The Screw.

These may be divided into two simple powers, of which the other four are combinations or modifications. The lever and the inclined plane are the simplest ones.

The common poker wherewith a fire is stirred is a familiar example of the lever. The poker is suspended on the bar of the grate as a fulcrum, the power or force with which it acts depends on the proportion in which the radius or circle described by the hand in moving it, exceeds the radius or circle described by the coals which are moved: in simpler language, in proportion as the length of poker outside the bar exceeds the length of poker inside the bar. The handle of a common pump is another familiar instance. The type of the lever may be found in nature, in the tree, which, spreading farther into the air than it does into the earth, is acted on by violent wind, and in falling, tears up the solid ground with its roots. In this case the elastic force of the air is the mover. Another type is found in the ocean cliff, which becoming gradually undermined by the influx of the wave, at length projects far over the strand, till it acquires a leverage overpowering the cohesion of its material, and then comes gravity to weigh it down and leave a mass of ruins on the margin of the sea, which by the friction of attrition gradually reduces it into sand.

An inclined plane is a straight surface, one side of which is lower than another—or, in other words, which dips downward from a horizontal level and forms an angle with it. It is the especial instrument with which gravity works. Where a rolling body is placed on a sufficiently inclined plane, the centre of gravity or weight overhangs the base or bearing point, and motion ensues, which only ceases when the horizontal level causes the centre of gravity to fall within the base. A wheel carriage rolling down hill is a familiar example of the use of an inclined plane. But it

is clear that an inclined plane must be useless for the purposes of motion without the intervention of the lever. When we say that the centre of gravity overhangs the base, we merely mean that the contact point or fulcrum of the body is not in a vertical line with the centre of gravity. A line drawn from the axis to that part of the periphery which impinges on the ground does in reality constitute a lever which the force of gravity impels downwards or towards the centre of the earth. In nature the inclined plane is found in numerous positions of high utility. The hills and the valleys are inclined planes, which drain off the surplus moisture and prevent the earth from becoming a quagmire: the beds of the rivers are inclined planes for the efficient motion of the mingling mountain streams: the ocean beach is an inclined plane, down which the dashing surf rolls back to join its parent water; and the sides of the hoary rocks of the lofty mountain ridges are inclined planes, down which the fragments shattered from the peaks by the winter's frost, roll to the higher valleys formed by the snowy rills, there gradually to be decomposed and play a new part in creation.* In all these cases gravity is the moving force.

The wheel and axis consist merely of a series of levers planted round a common centre. In the common framed wheel every spoke is a lever. When the wheel is fixed on a horizontal axis, two of the spokes are vertical, and as the horse draws forward, each pair of spokes in succession be-

* Geologists say that these very mountains have been originally raised up by the elastic force of heat. If so, elasticity is in the very outset the awakener or employer of gravity.

come vertical. When a spoke is vertical, it constitutes a lever reaching from the line of draught, which is the axle, to the ground: therefore, the longer the spoke—or, in other words, the higher the wheel,—the more powerful is the lever.

The wedge is an inclined plane, the action of which is reversed or modified by being made movable. It is mostly used by the force of concussion, as the blows of a hammer or sledge; which is a modification of the power of gravity, the centre round which the weight moves being the ball and socket joint of a man's shoulder. But the wedge may also be acted on by a lever, or lever and screw, and may be used either for the purpose of raising or lowering a body. A large ship, when on the stocks, is secured upon a series of wedges; these wedges being loosened, she slides down the inclined plane into the water.

The pulley is simply a small wheel and axis, around which a rope runs in a groove. The convenience of the pulley is, that it may be multiplied many times for the sake of increasing the power at the expense of the time: *i. e.* a series of levers are brought into action at once by means of a longer rope.

The screw is a movable inclined plane, not straight, but in a spiral form. It is a modification of the wedge, and not intended to be moved by concussion, but by a lever, without which it is useless. The path of this movable spiral wedge is in a circle. It is used by mechanics either to cause bodies to approach to, or to recede from each other. An example of the former case is the common smith's vice, wherein the action of the screw is used

to impel the chops or gripping parts forcibly towards each other, to hold firm the work. An example of the latter case is the screw jack, used by builders to lift heavy weights, such as the walls of buildings which have sunk.

An authority of high repute, Mr. John Farey, author of the well-known work on the Steam Engine, has added to the ancient catalogue of the "Mechanical Powers" two others, viz.:

The Funicular Action,

The Hydrostatical Action.

The first is the force exerted by a cord or rope forcibly stretched between two supports to draw those supports nearer together. The archer's bow is the familiar illustration of it. The bow string is in this case merely the vehicle for transmitting the muscular or elastic force of a man's arm. The force which is given to the bow, and which serves to propel the arrow, is the force of elasticity, which is communicated by the man's arm temporarily, and more rapidly expended than communicated. The force employed in drawing the bow is the amount of force communicated to the arrow, minus friction.

The hydrostatic action in one form is the facility afforded by water as an agent in the transmission of force. The well-known Bramah's press is an illustration of it. It consists of a large and solid cylinder, in which works an accurately-fitted piston or plunger; a forcing pump of very small bore communicates with the cylinder, and by the action of the pump handle or lever, exceeding small quantities of water are forced in succession beneath the piston in the large cylinder, thus gradually raising it up.

and compressing bodies whose bulk or volume it is intended to reduce. It is evident that this press is merely a circuitous contrivance for accumulating together the separate efforts transmitted from the man's arm in each successive action of the lever or pump handle. Without the lever, the pump could not be worked.

To these two last mechanical powers may very fairly be added two others of a more complicated kind, which have long been in constant use. They may be designated

The Automatical Action,

The Ponderatical Action.

The first is the action of a coiled spring of steel, such as contains the moving power of a watch, a common bottle-shaped roasting jack, and many other contrivances. The spring itself is not a power,—it is merely the vehicle for holding the power communicated in a short space of time, by the elastic action of the human hand through the lever called a key, and which power it distributes by means of multiplied wheel work through a long space of time. This power is the representation of the force of elasticity alone. A simple form of this action is shown in the delicate spring coiled within the balance wheel of a watch, which keeps up a continuous resistant action. The spiral spring used to lift the screw of a large stamping press is another instance.

The ponderatical action is the action of a suspended weight which contains the moving power of a common clock, a common roasting jack, and other machines. The weight is not the power, but merely the vehicle for holding the power communicated in a short space of time by

the elastic action of the human hand through the lever called a cranked handle, and which power it distributes by means of multiplied wheelwork through a long space of time. The immediate cause of the weight's action is the force of gravity, of which it may be held the representative: but, again, that gravity only represents the elasticity of the hand first communicated to it. A simpler form of this action is shown in the safety valve of a steam engine, where the gravity of the weight constantly regulates the elasticity of the steam. The pendulum of a clock is another instance. Another is the governor or revolving pendulum of the steam engine, which regulates the issue of the steam. The common fly wheel for regulating speed is another instance.

Of the four powers known as "first movers," three only have been applied, or can be conveniently applied, to communicate motion to wheel carriages.* They are,

Animal Power,
Wind Power,
Steam Power.

All three may be used as external powers by which carriages of the secondary class can be moved; but they cannot all be used as internal powers to propel machines of the primary class. Only steam and animal power can be used at all as internal movers,† and only the former with

* A steamboat moving by paddle wheels may be called a water wheel carriage, but the water does not move it, it merely supports it.

† Wind carriages, made of light cane work and impelled by sails, are said to have been used by the Chinese at very early periods. Carriages impelled by large paper kites, and also by sails, have frequently been experimented on in England, but with little success. The

much advantage. Men might impel carriages internally by their muscular elastic force, but it would be an exhausting process, and horses could not very conveniently impel them by means of their gravity, while their elastic power would be unaided by impetus.

In a locomotive wheel carriage moved by the internal power of steam, the principle of action would be a combination of several of the "mechanical powers." Into the *action* of a wheel carriage of the secondary class, only two of the mechanical powers enter, viz.:

The Lever,

The Wheel and Axis.

The pole or shafts of a four-wheeled carriage are applications of the lever for the purpose of locking or turning. The shafts or pole of a two-wheeled carriage are applications of the lever both horizontally and vertically; the former for the purpose of locking, the latter for the purpose of supporting the weight at the proper level.

The wheel and axis is applied both to two and four-wheeled carriages, as the medium of progression on which the whole machine is supported. In four-wheeled carriages the perch-bolt is an application of the axis, as a centre around which the fore wheels and under frame turn through the medium of the pole's leverage.

principal reason of their want of success is, that they are confined to narrow roads, and have not an open surface, as sailing vessels have on the ocean. But they could at best only serve as vehicles of amusement. In an age of certain power like steam, no business people will, if they can help it, trust to the uncertain power of wind. On some short lines of railroad near the sea, the wind is commonly made available to drive cars by means of sails attached to them,—*i. e.* when the wind happens to be favourable.

The geometrical figures which enter into the composition of a carriage are,

The Plane,
The Circle,
The Ellipse,
The Square,
The Oblong,
The Rhomboid,
The Triangle,
The Prism,
The Cylinder,
The Pyramid,
The Cone,
The Parallelogram.

CHAPTER IV.

Materials of Wheel Carriages.——Animal:—Hides.—Skins.—Hair.—Wool.—Silk.—Glue.—Whalebone.—Ivory.—Pearl-shell.—Vegetable.—Timber.—Ash.—Beech.—Elm.—Oak.—Mahogany.—Cedar.—Deal.—Pine.—Fustic.—Lancewood.—Birch.—Chesnut.—Sycamore.—Plane tree.—Cotton.—Flax.—Hemp.—Tow.—Straw.—Caoutchouc.—Copal.—Linseed Oil.—Turpentine.—Mineral:—Iron.—Steel.—Copper.—Brass.—White Brass.—Gun-metal.—Silver.—Gold.—Lead.—Tin.—Glass.—Metallic Oxides.

The materials of which wheel carriages are composed, embrace the three great divisions of nature, called the animal, the vegetable, and the mineral.

The animal substances used in carriage building are, hides, skins, hair, wool, silk, glue, whalebone, ivory, pearl-shell.

The vegetable substances used in carriage building are, timber of various kinds,—ash, beech, elm, oak, mahogany, cedar, deal, pine, fustic, lancewood, birch, cotton, flax, hemp, tow, straw, caoutchouc, copal, linseed oil, turpentine.

The mineral substances used in carriage building are, iron, steel, copper, brass, white brass, gun-metal, silver, gold, lead, tin, glass, and various metallic oxides.

Hides are used both for purposes of suspension and also for coverings. The hides are those of horses and neat cattle, converted into leather by the action of oak and

other bark. They are afterwards smoothed and levelled by the currier; being occasionally split into two equal thicknesses by means of an engine; after which they are rendered pliable by the application of oil and tallow, and finished to a clear black or brown colour, as they may be required: this is called dressed leather. For some purposes the hides are merely levelled, put on wet to the object they are intended to cover, and left to shrink and dry. Others, again, are covered with a coat of elastic japan, which gives them a surface like polished glass, impermeable to water: in this state they are called patent leather. In a more perfectly elastic mode of japanning which will permit folding without cracking the surface, they are called enamelled leather. They are usually black: but any colour which is required can be given them. All this japanned leather has the japan annealed, something in the same mode as glass. The hides are laid between blankets, and subjected to the heat of an oven at a particular temperature during several hours.* Sole leather hides are also used for some purposes.

The skins are those of the sheep and goat. The former are converted into leather by the action of oak bark. In one form of dressing them they are known as basil leather, which is of a light brown colour and very soft. Sometimes

* The original inventor and patentee of this leather was a Frenchman. He lost his patent right, because in his specification he inadvertently stated the heat of the oven according to the thermometrical scale of Reaumur without naming it. It was held that as Fahrenheit was the English standard of thermometrical heat, the "degrees" named must be taken by that standard, in which case the specification was untrue.

they are blacked, and occasionally japanned, in the same mode as horse and neat's leather. In all these forms sheep-skins are only used for inferior purposes, as mere coverings, where no strength is required. The probable origin of the term basil is, that it was first manufactured at the town of Basle in Switzerland, and thence imported into England, ere it became a native manufacture.

Goat-skins are the skins used for preparing the beautiful leather known by the names Spanish and Morocco. They are not tanned in oak bark like other leather, but very slightly in an infusion of the bark of the sumach tree. They pass through many processes previous to that of dyeing; for which purpose they are sewn up with the grain outwards, and blown with wind like a bladder. This is to prevent the dye from getting access to the flesh side. This beautiful leather was originally manufactured by the Moors, who afterwards introduced the process into Spain; by which means it came to be known under the two names. The English manufacture has been so much improved on, that few others can now vie with it. These skins are used in carriages for inside linings.

Hair is used as an article of stuffing. To give it the peculiar curl which renders it elastic, it is forcibly twisted up in small locks, and in that state baked in an oven to fix it. The hair of horse's tails is the best, as being the strongest and longest; but various other kinds are used. Sometimes it is adulterated by mixing it with fibres of whalebone. Doe hair is also much used as an article of stuffing; but as it is very short, it cannot be curled, and there is very little elasticity in it.

Wool in its natural state is not used for carriage purposes. In the form of "flocks," which are the short combings and fibres produced in the process of manufacturing it, it is very largely used as stuffing. In a manufactured state great quantities are used for various articles, cloth, lace, fringe, carpeting, baize, serge, shalloon, binding, tufts, tassels, twist, occasionally plush.

Silk is used in various fabrics, such as tabbaret, velvet, ducape, lutestring, damask, and various others, for inside linings. It is also used for lace, fringe, embroidery, tassels, tufts, cord, twist, and lastly, for sewing.

Glue is prepared by boiling down refuse gelatinous substances.

Whalebone is used principally to fix to the under sides of lancewood shafts, to reinforce them on account of their extreme brittleness, just as archers' bows are formed of two pieces of wood, the more elastic and brittle being in the inner or concave side, and the toughest on the outer or convex side. These, however, are fastened by cement; whereas the whalebone is fastened to the shafts by means of bolts or screws. Whalebone has also been applied to the purpose of making wheels, but being an article of limited supply, the price rose so rapidly that the manufacture was discontinued.

Ivory is used for rollers, studs, and buttons; and sometimes for carving armorial bearings, crests, &c.

Pearl-shell is used for similar purposes.

The timber principally used in the construction of carriages is that of the ash tree grown in England. There are two kinds of it, known as "hedge-row" and "coppice."

The former, as the name imports, grows in hedge-rows and other open spots, and being exposed to the air and light, is of slower growth, but much firmer, stronger, and tougher than that of the coppice, which sprees up very rapidly without the access of air and light, and is proportionably soft, and not durable, though straighter grained. Ash timber brought from America is principally of this latter quality, being grown in thick forests, which are remarkable for a moist atmosphere.* But the quality of the timber also depends much on the soil in which it grows. Strong wheat lands are the best adapted to it. For the heavy framework much exposed to concussion, the timber is required in its greatest state of perfection, arrived at maturity, but not at the extreme size it is capable of at-

* The forests of America of ancient growth, where they have been untouched by the axe of the settler, present a remarkable appearance. There is no growth of underwood, for the absence of free air and light will not permit it to spring up. No sound is heard on the ground, and all is hushed and still. The breeze penetrates not to the person of the traveller, and he can but hear its distant murmur as it ruffles the lofty branches of the forest giants whose round naked stems bound his vision on every side, like an endless columnar temple from which, at rare intervals, can be perceived a glimpse of the blue arching vault, as though from the mouth of a well. At first entering the forest from the sunshine the eyes are blinded for a while, for the only light is a dim twilight. The earth is covered to a considerable depth with the undisturbed dust of decayed vegetation, and the footsteps are else unimpeded save by an occasional fallen trunk of an ancient tree, which mostly crumbles to fragments at the touch. It is over this stratum of fine vegetable dust that the Red Indian goes upon the "trail" of his foe, and hunts him to the death as surely by the sight as a bloodhound does by the scent. In such scenes, wearied with the gloom, the traveller almost wishes that fire would consume it and give the heavens to his view, and when a stream intersects his line of march, he blesses his happy chance that he can once more look on daylight.

tanning, for then it becomes of weaker texture, and is more fitted for such framework as, being removed from concussion by the intervention of springs, requires less strength. Ash is not, properly speaking, an elastic, but rather a tough fibrous wood, very capable of altering its form by the application of pressure, and therefore, when not in large masses, it requires iron plates to secure it. By boiling it becomes very plastic, and will take any required form, provided the thickness be not too great; but the soundness and durability of the wood is much lessened unless care be taken not to overboil it. Wood consists of fibres united by gluten. If boiled long enough, the gluten would all dissolve and the fibres separate. Hot steam does less mischief than hot water, because, as it does not make an infusion, it is less liable to carry off any of the gluten, which is the bond of union.—Some ash timber is white at the heart, and some red: the white is usually the strongest and best. Some trees which have been grown on hill-sides, much exposed to constant winds, present a remarkably wrinkled appearance through their whole length, and it is scarcely possible to plane their timber smooth: this is the toughest of all ash timber. Parts of ash trees are sometimes found of a yellowish brown colour, accompanied by a fetid acid odour. This is occasionally attributed to the effects of lightning; but the most probable solution of the matter is, a putrid fermentation of the sap takes place in consequence of an imperfect process in drying. All other circumstances being equal, that timber is best which is cut down when the circulation of the sap is slowest, as the pores are least open. In the process of drying, the mea-

surement of the trees diminishes considerably. One of the qualities which render ash peculiarly valuable for carriages is the absence of elasticity, and consequent indisposition to alter its form by its own internal efforts—that is say, it is not liable to warp or twist. Though excellent for framing, ash is not well adapted for boards or planks in which much width is required, as in drying it is apt to rend and open. It is also more expensive than other woods which are better adapted for boards. The diameter of ash trees used by carriage builders is from one foot to three feet six inches; but the latter is an unusual size. Altogether there are forty species of ash.

Beech is a wood which ought never to be used for carriages, or for any work which may be exposed alternately to air and moisture. It is, however, occasionally used by carriage builders, and also by wheelwrights, on account of its superior cheapness. It is extremely liable both to warp and to rot, and cannot be depended on; but when covered by water and kept constantly wet, it is durable.

Elm is a wood largely used in carriages for planking where strength is required. There are two kinds,—hedge-row, and wych or wick. The latter is an old Saxon name meaning stream or streamlet,—one of the tributary streams which run into main rivers, as Hampton Wick, Greenwich. The banks of such streamlets are generally composed of soft alluvial land, and the timber growing on them is mostly large, soft, and straight-grained. Such is the character of wych elm; but though every timber-dealer professes to sell such, it is very rarely met with. Hedge-row elm composes almost the whole supply. The diameter of

the trees is from one foot six inches to three feet six inches. The grain is curly and wavy, difficult to work, brittle, and apt to split, without care. It is not a good surface to paint on, as the grain shows through several coats of colour. The wych elm is more apt to split, but it forms a good surface for paint. Elm is used also for the naves of wheels. It is not so expensive a wood as ash. There are fifteen species of elm.

Oak is used in carriages for the spokes of wheels. The best kind are made of the timber of saplings, which are not sawn but rent in the direction of the grain, in halves or in quarters according to their size. Inferior spokes are also made from the limbs of large trees. Oak is also used in plank under the name of wainscot, for boxes. The number of species is one hundred and forty.

Mahogany is very largely used for the pannels of carriages in such parts as are intended to show an even surface of paint. There are two kinds of mahogany, known as "Spanish" and "Honduras." The former grows on mountains and on the sides of ravines, and its favourite soil is where a profusion of limestone is found. In most of it, the pores will be found filled with a white powder, which destroys a cutting edge so rapidly, that cabinetmakers use what is termed a tooth plane to work it; *i. e.* the edge of the plane iron is composed of a number of sharp points like the teeth of a saw. This kind of mahogany is never used by carriage builders; as the beautiful curled grain which gives the effect of light and shade, so much prized by cabinet-makers, renders it unfit for carriage pannels, which in many cases require to be bent not merely in

a cylindrical, but also in a partially spherical form. For these purposes the Honduras wood is admirably adapted; as it can be procured, if required, upwards of four feet in width and perfectly straight-grained, and free from knots and blemishes. This timber is not all brought from the bay of Honduras, although originally it came from thence. Many parts of the Spanish Main abound with it. It is mostly found in low alluvial soil in the neighbourhood of rivers and marshes where air and light are not very abundant: therefore it is that the colour presents a blanched appearance when compared with the Spanish kind. There are several qualities of mahogany sold under the name of Honduras: some of it is very solid though straight-grained, and some very porous and curly, while other classes of the timber are very open-grained and straight throughout. There are three species altogether; one being found in the West India Islands and America, and which in commerce becomes "Spanish" or "Honduras" according to its soil and locality. The other two species are natives of the Eastern Indies.

A coarse-grained species of cedar, of considerable width, which is brought from the same districts as the Honduras mahogany, is sometimes used for carriage pannels which are to be covered over with leather or other substance. Its extreme porosity renders it unfit to serve for a painted surface.

Deal is very largely used for the flooring of carriages, and also for covered pannels, occasionally glued by the edges to get a sufficient breadth. The word "deal" refers

merely to the form of the timber, and not to its quality. *Deal* means *portion*.

The wide American pine is chiefly used in very thin boards to form the covered pannels and roofing of carriages.

The hard yellow wood called fustic is occasionally used to form the naves of wheels which are intended for hot climates, as they are not so subject to shrink as the woods of English growth. This wood is a native of the Isthmus of Panama, of Brazil, and of the West India Islands. It is a species of mulberry.

Lancewood is a straight-grained elastic but highly brittle wood, brought from the West India Islands in the form of taper poles about twenty feet long, and from six to eight inches diameter at the largest end. This wood was formerly much used for shafts, but it is more disused of late on account of the curved forms which have become fashionable. Lancewood can be bent into form by boiling; but it is altogether a very unsafe material to trust to for so important an article as shafts, the breaking of which frequently occasions the loss of life. The grain is yellow, and close as box.

American birch is a most valuable wood for flat boarding, inasmuch as it can be procured of great widths; from one foot to two feet six inches, and occasionally three feet. It is of a perfectly homogeneous substance, free from rents, and with scarcely a perceptible pore. It works easily with the plane, and yields a beautifully smooth surface, which does not show the smallest particle of grain beneath the

most delicate paint-work. It is even as stretched canvass. It is not very straight-grained; but this is not important. The greatest defect is its brittleness, which will not admit of its being used for any but plane surfaces; and then much care is required in bolting, screwing, or nailing it. The price is not much higher than American pine. It is of the bark of this tree that the Indians of North America make their beautiful light canoes, which are merely sewn together: some of them will carry twenty men, yet are so light that they may with facility be carried by two. The trees grow in alluvial soil with little air and light, and are principally cut down for the purpose of clearing land; so that it is to be feared the time will come when they will be much scarcer,—at least the larger trees. It would be a valuable kind of wood to introduce in England as a plantation tree.

Of late, the great increase in the construction of carriages for railroads and other public uses has caused a scarcity to be felt in the ordinary timber, and chesnut, sycamore, plane trees, and other woods are now occasionally used.

Cotton is used in the manufacture of carriage lace, as an under body on which to weave the surface. But it is generally considered an inferior material. It is also used for waterproof material with India rubber.

Flax and hemp are largely used in the form of sewing-thread, twine, cord, and rope; and also for floor-cloth, linen and canvass, and the purposes of lace-making. Tow is generally used as stuffing where a more solid substance than hair is required.

Straw is used in small quantites for stuffing coachmen's

seats exposed to the atmosphere; also for stuffing the leathered parts of poles.

Caoutchouc, or India rubber, is a most valuable article in carriage building where pliability and impermeability to water are required in conjunction. It is a gum prepared from the sap of trees, the growth of some parts of Southern America. It is also found in Ceylon. The American Indians early discovered its valuable properties as a vehicle for containing water. Their usual water-vessels were made of gourds or calabashes, but which were liable to break with a fall; a defect causing much inconvenience on a journey. When the caoutchouc gum was first used in their stead, the Indians took for models the calabashes, to give form to their new inventions. The process was, to mould a lump of clay to the desired shape, and wounding the tree, to suffer the sap to flow over it till the desired thickness was attained. The sun's action rapidly hardened it, and then the inner mould was washed out with water; the result being an elastic bottle well adapted for carriage, and not capable of being broken. These bottles were first brought to Europe as articles of curiosity, and eventually as articles of commerce, when their utility as a rubber or cleanser was discovered. For a long period they were applied to no other purpose, as chemistry had not furnished the means of dissolving and re-hardening them. Even when this difficulty was vanquished, the material still continued for a long period to be brought over in the form of bottles. Ultimately it was brought over in large squares, which were cut by a machine into thin slices, used for various purposes. The process was then discovered of dissolving the

material so that it would again harden to its former consistence. For making water-proof cloth, two thicknesses are required, either of woollen, linen, cotton, or silk. The caoutchouc is spread on one in its liquid state, and the other is pressed upon it by means of heat. The union is so perfect, that it requires very considerable force to separate them afterwards; and though the film of gum is exceedingly thin, it is both air and water tight. The natives of Columbia had adapted this material to the preparation of water-proof cloaks long before it was so used in Europe; and their cloaks are the most perfect, inasmuch as they prepare them with the fresh gum from the tree, and not from an artificial solution. The gum after artificial solution and re-hardening is never so tough as at first. In using it as rubber, it is not so efficient, and wears away very rapidly. Waterproof material prepared with caoutchouc, will not bear the contact of oil or grease without being destroyed. The cloaks used by travellers on horseback, are spoiled by coming in contact with the sweat of the horse.

Copal is a transparent resin of a faint yellow colour, brought from Southern America. All carriage varnish is prepared with it, as it is very tough and not easily cracked or worn.

Linseed oil is used in the preparation of paint. It is extracted from the seed of the flax by expression.

Turpentine is a product of the fir tree, and is used with paint in the form of a thin liquid in order to give it drying properties.

The metal which is most abundantly used in carriage

building is iron. The consumption of it is enormous. It is used in the cast form for the boxes of wheels, and in the wrought form it is used in almost every possible shape, from the wheel tire, the axle, the crane, the bar, the stay, the hinge, the plate, the bolt, up to the most minute screw and nail. The quality most known and preferred is that called, after its mark, "King and Queen." *

Steel is likewise a metal of great consumption for the manufacture of springs. It is not of a very fine quality; far less carbon enters into its composition than into that of the finer steels used for cutting implements, and clock and watch springs, cross-bows, &c. The spring-makers assert that steel of a finer quality would not answer so well, as it would be more liable to break by concussion, but this is mere assertion, and not borne out by facts.

Copper is much used for the preparation of beading which covers joints, and is intended to be painted. It has also been occasionally used for panels.

Brass, an alloy of copper, is used in innumerable ways; as, beading, wheel hoops, plates, locks, rings, buckles, and for other purposes, both useful and ornamental.

White brass, another alloy of copper, is a material which has lately come into use, known under various

* This iron is called "scrap iron," being prepared from the fragments of worn wrought iron collected in London and its neighbourhood. This is placed in furnaces, and welded in masses under a very heavy tilt hammer, after which it is passed between rollers and converted into bars. This is a similar process to that by which old horse-nails are converted into gun barrels. The intelligent proprietors of the King and Queen Iron Works at Rotherhithe would much benefit the public by adapting their machinery to forge axletrees and similar ironwork, at present imperfectly executed by hand labour, with a destructive wear of human life.

names, as, albata, German silver, &c. It is now used in carriages to some extent, for ornamental purposes. But neither white nor common brass can be used for purposes requiring much strength. In such cases iron is used, and the brass is plated on them in a thin sheet by means of solder.

Gun-metal is another alloy of copper, which is used to make axletree nuts, in preference to brass, as it is tougher, and not so liable to corrode with oil.

Lead and tin are both used in the preparation of solder; of which there is a large consumption, especially for filling up the hollow parts of beading and chased work.

Silver is largely used for ornamental plated work, and occasionally as pure metal. Lamp reflectors are plated with silver.

Almost the only form in which gold enters into a carriage is that of leaf gold for the purposes of the herald painter.

Glass is an item of considerable importance. Where the window frames are not divided by cross bars, it is necessary to use plate glass for strength; and its superior beauty, independent of other considerations, always secures it a preference, notwithstanding the extra expense. For lamp glasses however it is not required, clear common glass being sufficient. Cut glass has not hitherto been used in carriages for ornamental work; but it might so be used to great advantage.

Almost all the metallic oxides capable of being used in paint as colouring matters, are applied to carriages. Vegetable colouring matter is rarely used, as it is liable to change with the action of the atmospheric air and light.

CHAPTER V.

Analysis of Carriage Construction.—Dennet. Stanhope. Tilbury. Cabriolet. Curricle. Underspring Phaeton.—Coach. Parts of Coach. Carriage Body.—Equipage for Town and Country.

The component parts of the simplest kind of two-wheeled spring carriage for one horse are,

The wheels, the axle, the springs, the carriage,—which consists of the shafts connected together by cross bars,—the steps, and the body or sitting part, to which are attached the lamps.

The body is composed of the framework, the jointed hood or head covered with leather, the lining, the cushions, the driving box, the dashing frame of iron covered with leather, to keep off the mud and dirt thrown up by the heels of the horse, and the apron or knee boot.

The Dennet and Stanhope are the existing specimens of this kind of vehicle.

In the next class of two-wheeled spring vehicle for one horse, pliable leathern braces are introduced between the springs and the body of the vehicle. In this case, suspension brackets must be introduced. The Tilbury and the Cabriolet are the existing specimens. In the former, an iron bracket like a double gibbet is affixed on the hinder part of the carriage, and two shorter ones are affixed for

ward beneath the shafts. In the cabriolet, two iron brackets called loops are affixed to the hinder part of the body, to suspend it by braces from the upright circular springs: forward, two small brackets are affixed beneath the shafts, to take two straight springs which are bolted to the body.

In the two-wheeled vehicle for two horses called a Curricle, there are no shafts. The body is suspended in a similar mode to the cabriolet, on a frame consisting of two side pieces and two cross bars at each end. A pole is inserted into this frame, which passes between the horses and is suspended from a metal bar resting on their backs. The principle of yoking therefore is precisely that of the classic chariot. When this vehicle stands without the horses, it is necessary to support the fore end with a rest, which is a light frame resembling a short ladder hinged on to the fore end.

The simplest kind of four wheeled spring vehicle for one horse is called an Under-spring Phaeton. It consists of a long deep-sided box, usually painted black, the fore end of which is fitted to a body resembling that of a dennet or stanhope, while the hinder one carries an open seat. Between the hinder end of this box and the axle are secured a pair of double elliptic springs to give ease of motion. Beneath the fore end is secured a circular plate of iron and some strengthening framework. Beneath this is a frame called the under carriage, turning upon the perch bolt; to this frame the fore springs and fore wheels are attached, and also the splinter bar and pole, in lieu of the shafts, when it is intended to draw with two horses instead of one. A great variety of carriages are built on this same

principle, the difference being in form, and not in mechanical construction.

The next class of four-wheeled spring vehicle is that in which the body is connected with the under framework by pliable braces of leather attached to the springs. In this case, the framework which supports the fore and hind springs is connected together by a long central piece of timber plated with iron, called the perch. The fore framework is provided with a wheel plate, beneath which the under carriage and fore wheels work or lock round the perch bolt, as before described. The springs are of a circular form, and placed in a vertical position. An iron perch called a crane neck is sometimes used instead of a wooden one.

The next class is an improvement on the last, by using double sets of springs, viz. horizontal springs placed immediately on the axles, to intercept the concussion of the wheels, and sustain the whole weight of both body and carriage, and also circular upright springs, to sustain the body. For the purpose of procuring mere ease of motion to the passenger without regard to other considerations, no improvement upon this mode of construction has yet been brought into use. The close carriages built upon this construction are called Coaches and Chariots. Those made to open occasionally are called Landaus and Landaulets. Those permanently open with a leathern hood or head are called Barouches and Barouchets. A variety of this last are called Britzschkas.

For an analysis of parts, the Coach may be selected in its most finished state as the chief of every class, and from

which the constructors of pleasure carriages take their usual designation of "coach-makers."

An Underspring Coach is usually so constructed that it may serve as a town or travelling vehicle, by changing certain equipments called technically "town and country furniture." The component parts are the

Wheels,

Axles,

Under Springs and Dumb Irons ;

Beds, or cross framing timbers, which are technically called the fore axle bed, hind axle bed, fore spring bed or transom, hind spring bed and horn bar ;

Perch, or central longitudinal timber ;

Wings, which are spreading sides hooped to the perch and framed to the hind beds ;

Nunters, or small framing pieces, which help to bind the hind beds together ;

Hooping Piece, — a piece of timber scarfed and hooped to the fore end of the perch to secure it to the

Wheel Plate, which is a circular iron cased with wood, bolted beneath the fore beds, and beneath which the under or fore carriage turns. The fore carriage consists of the fore axle beds, into which are framed the

Futchells, which are longitudinal timbers supporting the

Splinter-bar and the

Pole.

The hinder end of the futchells support the

Sway-bar,—a circular piece of timber working beneath the wheel plate. A circular piece of timber of smaller size supported on the fore part of the futchells for a similar purpose is called the

Felloe Piece,

On the splinter-bar are fixed the

Roller Bolts, for fastening the traces.

On the pole is affixed the

Pole Hook, to secure the harness.

The perch and beds are strengthened with iron plates where necessary; and the other iron work consists of

Splinter Bar Stays, to resist the action of the draught. Formerly these were affixed to the ends of the axles, and called "wheel irons."

Tread Steps, for the coachman to mount by:

Footman's Step;

Spring Stays.

On the beds are placed

Blocks to support the

C Springs; to which are attached

Jacks, or small windlaces, and

Leathern Suspension Braces, which bind around the convex surfaces of the springs.

All the wood work is lightened in its appearance as much as possible by the introduction of carving and beading, and these parts constitute what is technically called the *carriage*, *i. e.* the framing which supports the body or sitting part.

The body is a species of box fitted with doors and windows, and lined and wadded for the purpose of comfort. As the bottom is the part by which it is suspended, it is of course there that the greatest strength is necessary. The two side bottom timbers are bonded together by two cross timbers called bottom bars, which are firmly framed into them. To give depth to the floor without destroying the symmetry of the side, deep pieces of elm plank are fixed to the inside of the side bottom pieces, and to these the flooring boards are nailed, being additionally secured by strap plates of hoop iron nailed beneath them. In the central portion of the bottom sides are framed the door posts called "standing pillars." At the angles of the bottom framework are scarfed the corner pillars. The cross framing pieces which connect the pillars are called rails. Two of these rails stretching across the body inside, between the door posts, are called seat rails, and serve to support the seats. To form the roof, arching timbers are laid across from side to side. The doors are framed double to contain a hollow space for the glasses and blinds, and they fasten with a wedge lock forced into a groove by a lever handle. There is one window in each door, and one in front: behind, there is a small light with a fixed glass. The doors of the best carriages are always hinged with secret hinges, not showing on the exterior,—for which purpose they are made with a cranked lever working eccentrically. The panels are of mahogany, fitted into grooves and strengthened by batons. The roof is of thin pine covered with japanned leather; and the bouge or sword case, which projects behind, is formed in the same manner.

Bouge is a Saxon word signifying, to bulge out, as an excrescence, which it in fact resembles, being originally an awkward contrivance to enable gentlemen riders to stow away their swords on a journey. The body when complete consists of

The Frame or Case,

The Doors;

The Glasses, which are fixed in thin frames of wainscot covered with cloth or black velvet;

The Blinds, which are sometimes panels and sometimes Venetian, so adjusted with springs that the bars may stand open at any required angle;

The Curtains, of silk, which slide up and down on spring rollers;

The Lining and Cushions, of cloth, morocco, silk, hair, lace, &c. The cushions are occasionally made elastic by the addition of springs of coiled wire.

The Loops, which are stays or brackets of iron bolted to the bottom, one at each corner, for the purpose of suspension to the springs;

The Check Brace Rings, to which are attached leathern braces from the spring heads, to prevent the body from swinging too far fore and aft;

The Collar Brace Rings, to which are attached leathern braces from the perch to prevent the body from swinging too much upwards or sideways.

The Steps, which are made to fold up and fill recesses in the doors when they are closed;

The Lamps, which are affixed to the upper part

of the fore end of the body, by means of iron stays.

When the coach is intended for town use, there is affixed on the fore beds a

Salisbury-boot, which carries the coachman's seat, hammer cloth, and foot board. This is consider-ed the most perfect equipment; but sometimes in lieu of it is used a

Coach-box, which consists of a light open frame fixed to the beds, carrying the seat and hammer cloth, instead of the much heavier Salisbury-boot. But the coach-box does not harmonise so well with the general appearance of the carriage as the Salisbury-boot does.

On the hinder beds are fixed two carved wooden blocks, which support the hind footboard. On the hind footboard is placed a frame covered with leather and stuffed, for the convenience of standing firm. This frame is adorned with carved wooden uprights and ornamental iron work, and the name given to it is Hind Standard. Its principal use is to fill up the hinder part of the carriage, which would otherwise look naked. At the back part of the body are attached the

Holders, which serve for the servant to steady himself by. They are merely strings of lace or webbing secured by staples.

When the coach is wanted for the purpose of travelling, the boot or coach-box with the coachman's seat is removed, and its place supplied by a box called a Platform-boot,

which carries luggage inside. On the top of the platform a trunk is fixed.

The hind standard, footboard, and blocks, are also removed from the hind beds, and a Rumble, or boot with a seat for two servants, takes its place. Under the seat of this boot there is a luggage box. At the back part of the body is fixed a large trunk called a Cap-case. Under the seats inside are two wainscot boxes, and on the roof are one or two very large flat shallow trunks called Imperials. In addition to these, Wells or deep boxes are sometimes placed beneath the bottom of the body, one on each side of the perch. A drag staff, chain, and shoe, and tool budget, are also necessary appendages on a journey.

The different items thus enumerated as forming parts of a first-rate under-spring coach, with various alterations as to shape and form, enter into the composition of most four-wheeled carriages. Some are occasionally omitted, and some few others are occasionally added. The pole is of course applied when the carriage is in use. It is fixed between the futchells and secured with an iron pin. At the front end of the pole is affixed a double staple, to which the leathern straps called pole pieces are attached, to hold the horses in a proper position, and prevent the carriage from overrunning them when descending a hill.

The foregoing notice of the different parts of a coach is merely the enumeration of their names. Many of them require an accurate analysis in order to make the reader understand their advantages and defects. Those parts are, the

Wheels,
Axles,
Springs,
Iron Work,
Lamps.

The simplest mode of treating them will be to take each subject separately, and analyse all that relates to it.

CHAPTER VI.

Wheels.—Definition.—Solid Wheel.—Plank Wheel.—Framed Wheel.—Barrow Wheel.—Nave.—Spokes.—Felloes.—Cylindrical Wheel.—Conical Wheel.—Pyramidal Wheel.—Nave Hoops.—Nave Tyres.—Hoop Tyres.—Mode of Construction.—Disadvantages of Modern Wheels.—Solid Felloes.—Hancock's Wheel.—Tubular Spoked Iron Wheels.—Losh's Wrought Iron Wheels.—Jones's Pyramidal Iron Wheels.—Weight of Wheels.—Elasticity.

A WHEEL for a locomotive vehicle is a circular roller, either cylindrical or conical, the width or thickness of which is considerably less than its diameter. It may be either solid, or constructed of various pieces: in which latter case it is called a framed wheel. It may also be made of wood or metal, or of a combination of both.

A solid wheel, such as is used still in countries where the arts have made little progress, is formed of a short length cut from the bole of a round tree. Solid wheels are also made of cast metal.

The simplest form of framed wheel is that made of planks set together side by side and crossed by other planks, the whole united by nails or trenails.

The next form of framed wheels is when an exterior circle is formed of wooden segments on which planks are nailed.

The next form is that in which two spokes at right

angles are made to pass through an axis, and segments of a circle are framed on to their extremities. The common barrow wheel is a specimen of this class.

The next form is when the wheel is composed of three distinct parts, viz. the Nave, the Spokes, and the Felloes.

The Nave in its simplest form is a short cylindrical block of wood forming the centre of the wheel, and pierced longitudinally with a conical hole to admit an axis.

The Spokes are arms or radiating levers framed into the nave at equal distances to form a circle.

The Felloes are circular segments framed on the extremities of the spokes, forming the tie or arc to them, and securing the whole together.

The simplest form of this wheel is when the framework is made to form a plane surface, *i. e.* perfectly cylindrical.

The next form is when the wheel is not a plane surface, but is dished or conical; *i.e.* the centre is made to fall back from the level of the felloes, so that the spokes form an angle with the central line of the nave.

The next form is that in which the nave is made sufficiently long that the spokes may stand at an angle with each other, alternating both ways so as to render both surfaces of the wheel conical. A wheel in this form is the strongest that can be made, as the centre or nave is the base of a pyramid of which the felloes form the apex. But though this wheel will support a very heavy load, it cannot bear much concussion, owing to its want of elasticity.

Wheels which were made before the introduction of iron were of course very clumsy in their construction, in order to give strength. Specimens of them may still be seen in

the broad wheels of waggons, technically termed rollers. The naves of these wheels are of enormous size. But when the naves of wheels were reduced for the purposes of elegance, a thin hoop of iron was applied both to the front and back, to prevent them from bursting by the strain of the spokes. When the felloes also were reduced in size, straps of iron called strakes or streaks were applied to their convex surfaces, covering the joints. But the last improvement was the most important of all, viz. the application of what is called a "hoop tire" instead of a "strake tire;" *i. e.* the tire forms a solid hoop which is put on the wheel warm, and as it shrinks in cooling, forces the whole of the framing together into a firm body.

It will be as well now to describe the process of constructing the best wheels in use; such, for example, as are used to the coach before treated of.

The form of wheel which is now generally preferred in practice is of the dished or conical kind. When in use, the axle arm is slanted so far downwards from the horizontal line, that the lower spokes may be always in a vertical position. By this means the friction is undoubtedly increased, inasmuch as a wheel on a horizontal axle runs the easiest and lightest. When the axle arm is slanted downwards towards the point, the wheel has a tendency to bind harder against the shoulder, and the rubbing surfaces are thus increased in extent. But there are several advantages to set against this disadvantage. The collar or shoulder of the axle is firm and solid. The nuts or lynch pins, which prevent the wheels from coming off, are much inferior in solidity. Consequently there is an advantage in throwing a greater strain on the

shoulder collar than on the nut, because it is better able to bear it; and moreover, in case of the nuts or lynch pins giving way, there is not so much risk of the wheel coming off, as its tendency when on a level road is to run upwards towards the shoulder. Besides this, as the lower spokes are in a vertical position, the upper ones spread considerably outwards, and thus afford a greater space for the body between the wheels, without the track on the ground being increased. The last advantage is, that the mud collected by the conical wheels is thrown off from the carriage.

The hind wheels of a coach such as before described vary in height from four feet three inches to four feet eight inches; the fore wheels are from three feet four to three feet eight. The number of felloes in the circumference varies according to the number of the spokes, two spokes being inserted in each felloe. Fourteen spokes are the usual number to a hind wheel of ordinary size; twelve to a fore wheel. When the nave of elm wood has been turned to its size in the lathe, it is marked for the spoke mortices, and firmly fixed at a convenient height at such an angle with the horizon as corresponds to the intended dish of the wheel. Two holes are then bored in each mortice in succession, after which they are squared out with proper chisels. Truth of eye and skill of hand are the workmen's only guide in this operation; though it is evident that it is the most important operation of the whole, as upon it depend the accuracy and solidity of the wheel when finished. The tenons of the spokes,—which are portions of dry rent oaken saplings,—are then cut to fit the mortices, parallel in their thickness and slightly wedging in their width. The other parts of the spokes are only partially

prepared. Every alternate spoke is then driven by blows of a maul, the workman guiding it as well as he can in a proper direction till it abuts upon the shoulder. But it is evident that the position which each spoke will take is by no means certain. The spokes are driven very tight, and wood, not being of a homogeneous texture, will yield more in one part than another; and the mortice, cut as it is by sleight of hand, must be uncertain. Every alternate spoke being driven, the remainder are then driven in between them in the same manner. After this, the spokes are finished to their proper form; and the lengths being measured from the nave, the outer tenons are cut to a cylindrical form, leaving the back shoulder square, to abut on the felloe with more firmness. The back of the spoke is rounded to a semicircular form in nearly its whole length behind; in front it is worked to a knife-edge, for the sake of a light appearance. The felloes are then fitted on the spokes, and jointed together. Holes are then bored in the ends of the felloes, and a small piece of wood, called a dowel, is inserted, which serves as a tenon to connect them together. The felloes being then driven home, wedges are inserted in the ends of the spokes to keep all firm. After this, the tire, welded into a solid hoop, is heated and put on. As it shrinks in cooling, the wheel cracks and compresses beneath the force. Iron pins are then driven through tire and felloe, one on each side of every joint, the points being riveted inside the felloe upon a small round plate of iron called a burr.

The result of this mode of making a wheel is, that

it is very imperfect when finished. Scarcely any two wheels are alike. Scarcely any spokes in a wheel radiate alike: some are apart an inch more than others; and as the shrinking of the tire varies, some wheels, as a consequence, get more dish than others, the spokes either compressing in the nave mortices, or yielding elastically in their length. To get them at all accurate, it is necessary to employ very skilful workmen; and as very skilful workmen are not very numerous, the cost of wheels is very much increased, beyond similar work in other branches. Another disadvantage attends them: a workman may put his work badly together, and there is no means of detecting it except in practice. A badly-framed wheel may show as well to the eye as a good one, and until it breaks down, no one, neither the master wheeler nor his customer, can detect the inaccuracy. Unless the master watches every wheel while the spokes are driving, he can only depend on the good faith of his workman.

There is no remedy for this evil except substituting machines for men's hands. The machine, if it cuts true once, will cut true always. Every piece of wood in a wheel ought to be shaped by machinery. The fellocs should be sawn to their exact size, curve, and length, by machine saws; they should be bored by machine augers, and rounded by machine shavers. The spokes should be tenoned by machine saws, and shaped by machine lathes. The naves should be turned by a machine lathe, and the mortices cut by a machine chisel: and the spokes should not be driven by the irregular strokes

of a maul, but be forced into their places by the regular pressure of a machine. And when the tire is put on, the wheel should be fixed in a frame, in order to preserve an exact size and shape. And when all these things are done, we may hope to procure wooden wheels alike in form and quality, and, moreover, accurately circular—which wheels at present are far from being. All the machines should be worked by a steam-engine. That wheels continue to be made by hand in England, is a somewhat remarkable thing, after the block machinery has existed so many years at Portsmouth. There is scarcely any article of manufacture for which there is so large a demand, and there is no variation in their mode of construction. It may, perhaps, be alleged that it would be cruel to turn wheelwrights out of employment by machinery; but such would not be the fact. The unusual cheapness of wheels would cause more to be used; and the probability is, that people would cease to repair old wheels, and thus the total number of workmen would rather be increased than diminished.

It seems, at first sight, a paradox to assert that a conical or dished wheel is stronger than an upright or plane one. To say that any body will stand firmer in a slanting position than in a vertical one, is a manifest untruth. The fact is, the advantage arises from the solid hoop tire: with a strake tire, the upright wheel would be the strongest. When running, the great lateral strain on the wheel is from the outside. Consequently, if the wheel be dished in an opposite direction, the thrust will be in the direction of the greatest resistance. The spokes can-

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not yield, because in yielding they increase the area of their circle, and this the hoop tire will not permit. Upon the same principle in carpentry which constitutes greater strength in the cambered or crooked beam than in the straight one, the dished wheel is stronger than the upright one.

When the tire is shrunk on the felloes, the spokes are forced somewhat into an arching form, and consequently have a tendency to regain their natural position. As the wheel revolves in use, the tire by the process of constant concussion is elongated as by hammering on an anvil; or the wood beneath it is compressed, which produces the same result. As the circle increases the spokes become more upright, and loosen in their mortices with the jarring. It is then necessary to take off the tire, and shorten it by the process called technically, "cutting and shutting;" when the spokes are forced back to their original position at the expense of leaving gaping orifices between the tenons and mortices at the back of the nave. Water gets in there; and thus the wheel becomes rickety, and must at last be replaced by a new one.

These known defects in wheels have given rise to many attempts at improvement. Amongst others, wheels were made with the felloes in an entire piece. Straight grained ash was selected of the requisite length and thickness, which by the process of boiling was softened and bent into a circle. It was imagined that this gave greater strength than the separate felloes, but such was not the fact. Wood is a substance consisting of fibres laid side

by side, and adhering together by means of a natural glue. If the wood were boiled long enough, the glue would all boil out, and the fibres would separate. It is evident, therefore, that the strength of wood must occasionally be materially injured by injudicious boiling. In addition to this, it was a difficult thing to get the felloe into its place in a single piece, and to repair a wheel thus made was wholly impracticable, unless by cutting away as much of the felloes as might be equivalent to the extent of the damage.

Attempts were subsequently made to form the felloes in two segments of boiled timber; but there was no advantage in it, and the plan was at length altogether abandoned.

During the process of experiments in the art of constructing steam carriages for common roads, the defects of ordinary wheels have been found to be a chief impediment. To obviate this, Mr. Hancock, one of the competitors in this branch of art, constructed a wheel of a novel but very efficient form. He abandoned the nave altogether; and instead of cutting the ends of the spokes into the form of tenons, he formed them into a series of wedges fitting each other, and forming a barrel arch, the ends abutting on the axle-tree box. Two circular flange plates were then applied laterally, and a screw bolt passed from one to another through the end of each spoke. Thus is constructed a very simple and exceedingly strong wheel; although the centre, from its large size, looks somewhat unsightly. But it might be reduced, and the wheel advantageously adapted to ordinary vehicles where very rapid

motion is not required, on account of the facilities it affords for the use of improved axle boxes, containing an abundant supply of oil.

When railroads were first brought into use as a mode of rapid locomotion, it was soon found that wooden wheels were not capable of bearing the work required of them at high velocities. Iron wheels, cast in a single piece each, were then tried, but were found to break down. Wrought iron tires were then applied to them; but though an improvement in the mode of construction, still the expense by breaking down was very great. A method was then devised of making the arms or spokes of drawn iron tubes, flattened to an oval form, which were laid in the moulds, and the centres and peripheries cast upon them. A wrought iron tire being then applied, the wheels were found to stand the work required of them tolerably well; and no better railway wheels have yet been produced, except those of Mr. Losh, of Benton House, who bends wrought iron bars into a triangular form, and then placing a sufficient number in a circle with their ends meeting in the centre, casts a solid axle box on them to unite them altogether. The outer sides, which form segments of a circle, abutting against each other, are then clipped with a grooved tire, which is shrunk on hot; and thus is formed a rigid wheel of perhaps the strongest form which art can accomplish.

The wheels of railway carriages are always upright, and the great velocity used is the cause of their requiring so much extra strength. Every irregularity, every slight blow is multiplied in its effects with a compound

force. Small pieces of gravel are felt as though it were a pavement of rough stones; an inequality of less than one quarter of an inch in the level of a rail joint is felt like a plunge into a deep hole, or an ascent over a formidable obstacle.

Impressed with the disadvantages attendant upon the use of wooden wheels, Mr. Theodore Jones projected a wheel made entirely of iron, and constructed with considerable ingenuity. The cast iron nave is of considerable length, and the round iron rods which serve as spokes are inserted at either end alternately; thus forming a pyramidal wheel, the apex of which is at the circumference, and the base at the nave. The spokes are fixed into the nave with a screw-nut, and the extremities are riveted through the iron rim or circumference; for this reason the proprietor called it a suspension wheel. The original wheels were made with plain rings of cast iron, which were found to fail, and consequently the proprietor replaced them by rims of rolled iron with a rib in the centre.

Ingenious as these wheels are in their mode of construction, they have not been found to answer all the expectations of the proprietor. For heavy carriages with a slow motion they are well adapted; but when they are required to be light, and are used with a rapid movement, the spokes are found to become very loose, and apt occasionally to break short off at the nave. Attempts have been latterly made to save them from concussion by attaching the axle to double elliptic springs, for light carts; but the expense must be considerably increased

by it. It is clear that elasticity is a necessary ingredient to ensure durability in wheels; and this is a natural advantage in wooden wheels over iron ones.

Wheels were at one time constructed for the street cabriolets on Mr. Jones's principle, retaining the cast iron centre, and substituting wooden spokes and wooden felloes instead of iron ones. A much lighter though clumsy-looking wheel was thus produced, and in reality a stronger one, inasmuch as the vibration resulting from the elasticity of wood is better adapted to resist shocks. But, notwithstanding, they have gone out of use.

Weight in wheels is a matter of less importance than in other parts of a vehicle, inasmuch as the amount of axle friction is scarcely at all increased by it. Wheels may be too light as well as too heavy. If there be a great weight resting on the axles, the wheels should have a proportional weight, or the carriage would have more tendency to overset. But of course, though the amount of axle friction would differ little with heavy wheels or light ones, very heavy wheels would require more draught power, inasmuch as they would add to the total weight of the vehicle, increasing thereby the amount of inertia. In going up hill this disadvantage would always remain; but on level ground, when a sufficient amount of velocity were attained, the weight in the wheels would have something the same effect as the fly wheel of an engine. But in practice the extra weight would mostly be found to act on the disadvantageous side, at least in vehicles moved by animal power.

Elasticity is important in wheels, both to increase

their general durability and to promote the ease of the traveller. Some years ago, a Mr. Hancock invented a wheel the spokes of which were made of whalebone. The aptness to split in this material was a considerable difficulty; but a still greater was the limited supply of the material which rose so rapidly in price, that it became necessary to abandon the project. To invent, plan, and bring to bear anything new, as an article of manufacture, requires much consideration. It is necessary, first of all, that it be not too costly; next, that it be generally useful; and lastly, that it be not constructed of a rapidly-exhausting material.

Most persons familiar with the wear of wheels must have remarked that the difference of durability in different sets of apparently the same construction is very great,—nay, that some sets of light wheels will last longer under the same weights and speeds than those which are apparently stronger. The reason of it is simply to be found in the relative degrees of elasticity. A well-made wheel properly tired will be found on examination, to have the backs of the spokes rounding, and the wheel, instead of being conical, will be dome-shaped. It will be an elastic dome, and the more the spokes are thus rounded,—provided the elasticity of the timber be not injured,—the greater will be the durability of the wheel, as it will contain within itself a power to evade the mischievous effects of concussion.

CHAPTER VII.

Axles ——Wooden.—Conical.—Iron.—Cylindrical.—Common Bar —Faggoted.—Sizes.—Lubrication.—Soap —Black-lead Grease. —Oil. — Common Axles with Linch-pins. —Screw Nuts.— Mail Axles.—Defects.—Collinge's Patent Axle —Process of Oiling.— Defects —Mason's Improved Collinge Axle —Various projects for Axles.—Essential particulars necessary to the perfection of Axles.

An axle, or axle-tree, for a locomotive wheel vehicle, is that portion of wood or metal, or both combined, which serves as an axis or centre for the wheels to turn round on.

The name axle-*tree* at once indicates the substance originally employed for it—viz. wood. Axle-trees are of two kinds; those which are fixed firmly in the wheels and revolve in gudgeons beneath the vehicle, and those on which each wheel revolves separately. The former, as being the rudest, were probably the earliest used. The earliest fixed axle-trees were simply pieces of hard timber with the ends rounded down into a conical form, that form being the easiest to fit to the wheel. Subsequently they were plated with iron to resist wear.

In the earliest iron axles, the conical form was still preserved, for the obvious reason of easy adjustment to the wheel. These iron axles were not made in a single piece, but were merely short ends bedded in, and bolted to a

wooden centre. Examples of these axles may still be seen in heavy carts and waggons.

The next improvement was to make axles of a single bar of iron; and this practice has now become common. An axle is technically divided into three parts;—the two *arms* and the *bed*, or that portion which connects the arms together. The commonest axles, which are manufactured for the sake of superior cheapness, are formed of a square bar, simply rolled to it shape between mill rollers. This iron is uncertain in its quality, as it is liable to have sand cracks, blisters, and other imperfections, which cause axle-trees made from it to break down with concussion. To guard against this, the best axle trees are formed of several flat bars of iron welded together in a mass, which process is technically called "faggoting." The size is regulated by the weight they are intended to carry. For a very heavy coach, from two inches to two inches and a quarter in diameter, and ten to eleven inches long in the arm, is an appropriate size. For light carriages, both four and two-wheeled, an inch and a half in diameter, and eight inches length in the arm, is a common size, and occasionally some are made as small as an inch and a quarter in diameter. It must be borne in mind, that a much less size would bear the weight, were the axles stationary, as in mill work; but for locomotive vehicles it is necessary to provide against the greatest concussion they can meet with in ordinary application.

When iron axles were first used, it was customary to drive an iron ring or hoop two or three inches broad into either end of the nave, to prevent the too rapid wear. This

plan is still occasionally used in heavy carts; but otherwise axles are always fitted with iron boxes adjusted to the arms with more or less accuracy, according to the price, and the material used for lubrication. For the prevention of friction in wooden axles, soap or black-lead are the best materials; for common coarse axles, a thick unctuous grease is the best adapted; but for axles which are accurately made and fitted to the boxes, there is no lubricating material equal to oil of the purest kind which can be prepared, *i. e.* the freest from mucilage or gelatine, according as it may be of vegetable or animal production.

The commonest axles now used are of a conical form, with a box of plate iron fitted to them. This box is made by welding the two edges of the iron together in a broad projecting seam, which helps to secure it in the nave. The inside of the box is sunk into hollows, for the purpose of holding the lubricating grease. At the upper end of the arm the axle is left square, and against this a broad iron washer is usually shrunk on hot. Against this washer the box works. To secure the wheel against coming off, a small iron collar is placed on the reduced outer end of the arm, and a linch-pin is driven through the arm beyond it.

An improvement on this kind of axle is when the collar at the upper end or shoulder is made solid by welding, and a screw-nut with a linch-pin through it is substituted for the collar and linch-pin. These nuts are commonly made six-sided, with a mortice or slot for the linch-pin through each side, in order to afford a greater facility for adjustment. In all other particulars this axle is the same as the last,

except that occasionally it is case-hardened to prevent wear and friction.

In travelling, these axles require to be fresh greased every two or three days, and the trouble thus caused is very considerable, besides the risk of omission, in which case the axle is likely to be entirely spoiled.

The other axles in common use are lubricated with oil.

The commonest kind of oil axle is called the "mail," because the peculiar mode of fastening was first used in the mail coaches. The arm is not conical, but cylindrical, in the improved kind. At the shoulder of this axle a solid disk collar is welded on for the box to work against. Behind this shoulder collar revolves a circular flange plate of wrought iron, pierced with three holes corresponding with holes in the nave of the wheel from front to back, through which long screw-bolts are driven, and their nuts screwed sufficiently tight against the circular flange plate, to allow easy motion. The wheel, when in motion, thus works round the shoulder collar, while the flange plate secures it against coming off. This is not neat or accurate, but it is simple and secure, and no nut or linch-pin is required to the axle in front, while the front of the nave can be entirely covered in. When screwed up for work, a washer of thick leather is placed between the shoulder collar and the box, and another between the shoulder collar and the circular disk which extends over the whole surface of the back of the nave. The box of this axle is of cast iron. The front is closed by a plate of metal, between which and the end of the axle arm an inch of space is left, as a reservoir for

oil, which is poured in through a tube passing through the nave of the wheel, and closed by a screw-pin. At the back of the box there is a circular reservoir for oil, three-fourths of an inch in depth and half an inch in width. When the wheel is in motion, the revolving of the box washes up the oil and gradually pumps it away from the front to the back reservoir, and all which is above the level of the leakage point—the bottom of the arm at the shoulder—gradually drips away. The oil in the back reservoir, being below the level of the leakage point, does not disappear so rapidly while the axle is in good order; but after no great length of time, by rain or the process of washing, the large leathern washer gets saturated with water, which by compression finds its way into the reservoir, and then of course the oil floats off by reason of its specific lightness. In short, the mail axle is very imperfect, and cannot be trusted without frequent examination when it has much work to do: but as it is neat in appearance, tolerably secure against accidents, and not very expensive, it is much used. Both arm and box are case-hardened.

The other kind of oil axle is that known to carriage builders as "Collinge's Patent." The original intention of the inventor was to make it a cylindrical arm, with the box running round it against a coned shoulder, and secured by a coned nut in front: but as it is found in practice that a leathern washer is necessary at the shoulder to prevent jarring, this part of the plan was abandoned. The axle as at present constructed consists of a cylindrical arm, with a broad shoulder collar. The box is of cast

iron, and the back of it is like the mail before described. The front of it has a rebate cut in the box to receive a small conical collar and the screw of an oil cap. The arm of the axle is turned down in the lathe to two-thirds of the total thickness, from the point where the rebate of the box begins. A flat side is filed on this reduced portion, and along it is made to slide a small collar of gun-metal, with a conical face in the interior to fit against the coned interior of the rebate in the box. Against this collar, technically called the "collet," a nut of gun-metal is screwed, and against that again, a second nut of smaller size, with a reversed thread, is tightly fixed. These two nuts thus screwed in different directions become as firm on the arm as though they were soldered there, and no action of the wheel can loosen them, because the collet, which does not turn, removes all friction from them. But, as a further security, the end of the axle arm projects beyond the farthest nut, and is drilled to receive a spring linch-pin. Over all, a hollow cap of gun-metal containing a supply of oil, is screwed into the end of the box.

When the wheel is in motion, the oil is pumped upwards from the cap and passes along the arm to the back reservoir, constantly revolving round the cap with the wheel. If the cap be filled too full of oil,—that is, if the summit of the column of oil in the cap be at a horizontal level above the leakage point at the shoulder,—it will pump away rapidly and be *wasted* till it comes to the level of the leak, where the remainder will be economically *used*. It is essential to the perfection of an oil action that the oil should not be

permanently above the level of the leak, but that small portions of it should be continually *washing up* into that position by the action of the wheel in turning.

In order to ensure their greater durability and greater freedom from friction, these axles and their boxes are always case-hardened; *i. e.* their rubbing surfaces are converted into steel to a trifling depth by the process of cementation with animal charcoal, for the space of an hour or two, when they are plunged into water. The boxes are ground on to the arms with oil and emery; either end being applied alternately, a nearly true cylindrical fit is accomplished.

The mode in which oil acts as a lessener of friction is by its being composed of an infinite number of moveable globules, over which the fixed surfaces of the arm and box roll without the abrasion or adhesion which would ensue if they came into actual contact. But this saving of the abrasion of the arm can of course only be accomplished by the destruction of the oil. This gives us one rule for guidance; viz. the greater the mass of the oil, the better and longer will the axle run. The bearing surface of the axle also should be sufficiently distant from the surface of the box to permit a film of oil between them; and it should be sufficiently extended so that the superincumbent weight may not *press out the oil from beneath it*, and thus cause an actual contact of rubbing surfaces. This consideration will sufficiently determine the *size* of axles. In a well-made Collinge axle, a wheel of three feet six inches in diameter, running on an arm of sufficient size, will travel five thousand miles without getting dry. A highly-polished surface

is important in an axle and box, inasmuch as the bearing is thereby flatter and truer. A rough surface is a surface of salient angles, which would pierce through the film of oil and produce contact.

But, perfect as these axles are, they are not secured against dangers arising from carelessness. The fit of the axle being so close, if by any chance the two surfaces are rubbed together without oil for a short time, heat is elicited, and the axle sticks fast in the box, the two surfaces uniting partially together. To guard against this as much as possible, the arm of the axle is reduced in thickness at the centre, for about an inch in length, to allow a lodgement for the oil. But in the process of work, as the wheel box revolves round the arm, it constitutes a circular pump which gradually draws up the oil from the front cap. If the sucker of a pump be allowed to get dry it fails to draw up the water; and just such is the case with the wheel. If, from carelessness, the wheel be put on with the box and arm dry, the capillary attraction of the oil from the cap will not take place, and when the wheel is in motion the metal will heat, and the wheel stick fast.

Another danger arising from carelessness is the introduction of grit into the box. The two surfaces being very hard, of course it requires some substance still harder to cut into them. In practice this commonly consists of particles of silex, which, cutting into the opposing surfaces keys them firmly together, so that it is frequently necessary to break the box in pieces to get it off the arm.

To remedy these defects, a patent was taken out by a Mr. Mason for a plan of casting three longitudinal trian-

gular grooves in each box. The advantages thus gained are, that if grit gets in, it finds its way to the bottom of the grooves, and does not interfere with the action of the wheel, and moreover, the grooves keep a constant surface of oil in actual contact with the arm, instead of trusting to the mere capillary attraction. Nor is the bearing surface altered by it, for the circular sinking round the arm in Collinge's plan is of about the same superficies as that of the grooves on Mason's plan.

The number of plans which have been devised, and patents taken out for improvements in axles, is almost innumerable; yet none have hitherto come into very general use save those enumerated. Mr. Hancock's plan for his wedge wheel is a deep circular chamber, open all round to the arm and cast in one piece with the box: it will contain a large supply of oil. The plan of Mr Jones, in his iron wheels, is to cast a semicircular hollow round his box open to the arm all round, and fed with oil by a thumb-screw from the exterior. Friction rollers have been tried, set in the box all round the arm, with oil contained in the hollows between them. The box has been sunk into fluted hollows, presenting only minute convex surfaces to the friction, and the interstices containing oil. Loose barrels have also been applied between the box and the arm, and the arm has been made a hollow cylinder.—But none of these contrivances are comparable to the Collinge axle with the grooved boxes. Some of them fail from want of sufficient bearing surface, and others from difficulty of manufacturing, or extraordinary expense.

To the perfection of an axle several considerations are necessary :—

That there be sufficient bearing surface for the arm to rest on ;

That the box be of a convenient shape for insertion in the wheel ;

That as large a body of oil as possible be kept in actual contact with the arm *by washing up as the wheel revolves ;*

That the column of oil may in no case be above the horizontal level of the leakage point while the wheel is at rest.

The possibility of accomplishing more than has yet been done as regards these objects will be treated of in a separate chapter on improvements ; but all carriage keepers, nay all cart keepers who understand the principles of economy—not the false economy of mere low price at the outset, but that true economy which takes into the calculation all that bears on the subject—will, as a matter of course, prefer purchasing the best made axles on Collinge's principle,—with grooved boxes,—to any other at present in use. The mere saving in oil or grease is almost motive sufficient, saying nothing of the labour and risk of taking wheels on and off frequently. And more than all this is the risk attending neglect of that which should be performed at very frequent intervals in mail and common axles, viz the oiling or greasing. If the wheel runs dry, the axle gets damaged, and perhaps breaks suddenly ; and this is a matter ordinarily left to the care of servants

It is sometimes objected to Collinge's axles, that if any

accident happens to them—such as a wheel sticking fast in the country, or on the Continent, their complication renders it a difficult matter to put them to rights. But this objection is not of much force; for, if necessary, common boxes for grease may be applied to them as easily as to any others.

CHAPTER VIII.

Springs.—Various Substances used for them.—Leather.—Whalebone.—Wood.—Metal.—Spring Steel.—Construction.—Defects.—Elasticity.—Varieties of Springs.—Simple and Combined Forms.—Straight Spring.—Elliptic Spring.—Regular Curved Spring.—Spiral Spring.—Examples.—Combinations of Springs.—Breakage of Springs.—Essential Qualities of a perfect Spring.

Springs, in locomotive vehicles, are the elastic substances interposed between the wheels and the passengers or load, in order to intercept the concussion caused by the wheels revolving on an uneven surface.

Many substances may be used for this purpose; as, thongs and straps of green hide, leather, catgut, hempen cord, caoutchouc, horn, whalebone, elastic wood, and metal. These may be used either separately, or in combination one with another. Elastic atmospheric air, or gases, might also be employed for a similar purpose.

In English carriages, the only materials actually employed for elastic purposes are leather, whalebone, wood, and metal.—Leather is used for suspension in the form of slings and braces. Whalebone is used to strengthen the under sides of lancewood shafts. Wood is used instead of metal, in the form of springs, in light one-horse vehicles, in order to avoid the tax to which spring vehicles are subject. But what is technically understood in carriages by the term "spring," is a plate or plates of tem-

pered steel properly shaped to play in any required mode.*

The earliest springs were probably formed of a single piece of steel; a mode of construction exceedingly defective, and liable to accident where there is no provision to limit its action. And in the mode in which the bodies of carriages are usually suspended, there is no provision for the rebound—as is the case with a bow, whose string restrains it by the ends—and a violent concussion would break a single plated spring. Experience in this

* The word *Steel* is probably more variously suggestive to the minds and imaginations both of the learned and unlearned than any word in the English language. It is associated with the poet's lore, the artist's inspiration, and the artisan's tool. It calls up hosts of ideas, as valuable to the imaginative writer as is the metal itself for the innumerable uses to which it is applied in the actual existing world. It brings the Iliad and Odyssey before us, and paints the gleaming axe-like weapons that flashed at Marathon and Thermopylæ, and the nodding plumes and stern features of the warriors who wielded them, piling up hecatombs of their invading foes. And old Rome, too, comes before us, with her cohorts, and the many nations through which they hewed their way; and our wild Celtic ancestors arise, with their chariots, and the "sharp scythes fastened to their axle-trees;" and Ragnar Lodbrog, and the Vikingr haunt our coasts once more, ringing their weapons, and deifying their fabricators in their Runic rhymes and wild war songs. And the hall of Odin is dimly seen, and the gnomes of the mountains of the North are flitting before us with their enchanted blades, whose edges no earthly material might resist. The steel rings of the ancient "hauberk's twisted mail" are clinking, and the plated war-suits are clanging to the tramp of "barbed steeds," and the dints of the quarrels from the cross-bows are heard: and William Tell starts up once more, and Highland claymores flash amidst "dirks and steel-wrought pistols," and "busy armourers closing rivets up;" and old Andrea of Ferrara ruffles it again in his bravery, with one of his exquisite blades twisted round his bonnet to sustain a plume, and another girdled round his

matter probably first led to the construction of springs of more than one plate, leaving their ends free to play against each other, and describe arcs, each upon its own centre, when in motion.

Springs for carriages are formed of a peculiar steel, of coarse quality, and into which little carbon enters: it is prepared expressly for this purpose. It is pretended by the spring makers, that better steel would not answer the purpose; but this is not the fact. The secret is, that the expense of material being greater, they fear the profit of the workmanship would be reduced; and moreover, the

waist to upbear the hilted weapon by his side. And the surnamed blades of Don Quixote's heroes, and "swords of Spain, the ice-brook's temper," and "Spanish blades," and "real Toledos," and the blood-dyed khanjar of "Anastatius" turned Moslem, and Mahratta tulwars, and Malay creases, and the fearful two-edged weapons of the true Indian Wootz, and Damascus scymetars, and Solingen blades, and the "Spanish Armoury," and London curiosity shops, and Walter Scott's library and armoury and novels, and Grose's Antiquities, and multitudes of old traditions and portions of history, crowd before us in an ever-moving picture, which, were the hands as nimble as the brain, might furnish many galleries of paintings. And then there have been secret springs to drawers, and desks, and carved oaken chests, and sliding panels, wherein steel has wrought the works of mystery. Nor has it less aided to give form to human imaginations of beauty. It served for the chisels of Phidias and Praxiteles; and while we little heed the clear ring of the modern trowel on coarse bricks, we may not forget that the same metal fashioned the marble columns and the friezes of the Parthenon, and cut the dies which have been the means of handing down to us coins and medals, in many cases the truest records of the periods in which they were wrought. Nor, while the steel anvil rings with the blows of the sturdy strikers who fashion our modern anchors, can we restrain our imaginations from wandering over the vast deep with the gallant ship to which the ponderous hook is to be the emblem and means of safety. And this again, calls to the writer's memory a beautiful poem which appeared in Blackwood's

workmen would be obliged to train themselves anew to work a different material from what they had previously been accustomed to. But it is not certain that a higher priced steel would increase the cost price of the springs; for a better quality of metal would be found probably more efficient and in that case a smaller quantity would suffice, thus making up for the increase of price. It must seem to every reasoner a paradox to assert that inferior metal is more efficient than the best, when, for cross bows, which have to sustain a severer trial than any to which coach springs are opposed, the best shear steel is used.

The steel used by coach-smiths is prepared by rolling-mills to any thickness and width required. The narrowest is about an inch and a half in width; the broadest, about three inches. The thinnest is about one eighth of an inch; the thickest, about three-eighths to half an inch.

A spring may be of two kinds,—double or single: *i. e.* tapering in one direction from end to end, or tapering in two

Magazine on the subject of forging an anchor,—one of the most vivid pieces of written painting he remembers ever to have seen. In the elder ages, when brute force obtained the mastery over mind, steel was alike the instrument and emblem of *power*, and the two-edged pointed sword, still borne by our statues of Justice, is a remnant of the olden feeling. A blind figure wounding on all sides, might be consonant to the old practice of making laws merely instruments of vengeance, but does not well represent the modern feeling, fast gaining ground, that laws should simply aim at restraint and correction. The precious metals, and the paper which represents them, are the modern emblems of power, but the real power resides, as of old, in steel. Steel digs the gold and the silver from the debris and from the hard heart of the mountain, and steel cuts the metal from which the paper is engraved. It were well, were it never applied to worse uses.

opposite directions from a common centre, as in a common crossbow. A spring composed of several plates, is hooped together with an iron hoop shrunk on hot, and riveted through at the point of fulcrum, whether it be double or single. The plate which forms the back of the spring is generally made thicker than the others, for two reasons: —first, that the bolt-eyes are generally formed in it, for the purpose of suspension; and next, that it is the longest plate. In carpentry it is found that the longer the beam, the greater must be the thickness, and a given proportion between length and thickness is maintained throughout. The spring makers recognise this principle in their longest plate, but they do not keep it up throughout; for though the longest plate is thicker than the rest, all the others are mostly alike in thickness, though their length gradually diminishes.

The process of making a straight double spring of four or more plates to cross an axle at right angles is as follows:—

The back plate being cut to the proper length, the ends are slightly tapered in the direction of their thickness, by the hammer, and curled round a mandril of the size of the suspension bolt. The side which fits against the other plates is then technically "middled:" *i. e.* it is hollowed by hammering so that the centre may be sunk below the edges. The next plate is then cut as long nearly as the first, and the ends are tapered down; after which it is "middled" on both sides. A slit is then cut at each end, about an inch in length and one quarter of an inch wide, in which a rivet head is

to slide and connect it with the first plate; so that whichever way the force or weight may act, these two plates sustain each other. At a little distance from this rivet, a stud is formed upon the under surface by a punch, which forces out a protuberance, sliding in a slit in the next plate; by which contrivance all the plates are retained parallel while they work. The next plate is prepared in precisely the same manner, with the exception that it is from three to four inches shorter at either end; and so on with as many plates as the spring may happen to consist of. The last one, like the first, is only "middled" on one side.

The plates being all prepared to shape, they are heated to the requisite degree by drawing them through a hollow fire: when they are plunged into water This is called technically "hardening." They are then drawn through the fire again, the workman occasionally rubbing a piece of stick over their surface till every part is of equal heat and will kindle the stick to a blaze. This is technically called "tempering." After this, the warps which the plates may have received in hardening are set straight by blows of a hammer; the workman taking care to have the plates slightly warm while doing it, to avoid the risk of breaking. This is technically called "setting." The plates are then filed in all parts exposed to view; *i. e.* the edges and points of the middle plates, the top and edges of the back plate, and the top and edges of the shortest plate. They are then put together, a square hoop is shrunk on hot, and a rivet being passed through it connecting all the plates with it, the spring is complete. After this mode

all carriage springs are made, whether they be straight or circular, double or single, the only difference being that the circular spring requires more setting.

It is evident that the whole process of spring-making is defective. In the first place, the plates should be tapered from the hoop to the points, which they are not, but merely at the points. In the next place, the plates should bear flat on each other throughout their width, which they do not, and being thinner in the middle than at the edges, they are more likely to break. In the next place, not being tempered in a large fire with a measured and accurate degree of heat, but depending entirely on the eye and skill of the workman, it is evident that they must be liable to inaccuracy. "Setting" also is partial breakage; *i. e.* the fibres are unduly strained.

Small articles, such as gunlock springs, are heated after hardening till they will blaze tallow or oil; and they are kept at this heat upwards of an hour, to ensure accuracy. Saw blades are tempered as accurately as watch or clock springs; and coach springs will not be perfect till similar modes shall be resorted to. The spring plates ought to be first forged, truly tapered, then "set" and ground to level surfaces, then tempered as sword blades are done.

The mode in which springs are at present constructed ensures their quick destruction. It is evident that the "middling" process produces a large hollow space between every two plates. Into these recesses the rain or the washing water finds its way, and forms a magazine of rust, eating away the hardened surface, in which most of the elasticity of the plates resides. The elasticity of a spring plate

somewhat resembles the elasticity of a common cane, which resides in the silex or hard covering. This silex being removed, the cane becomes non-elastic, and capable of permanently altering its form. A similar process it is which causes old springs to become soft and devoid of elasticity.* The appearance of rust oozing out at the edges, which is the case with all springs, is very unsightly. To prevent this, some builders require their spring-makers to paint the inner sides of the plates before putting together; but this is of little avail: it serves to impede the free action of the springs while it lasts, and soon getting partially rubbed off, rust is at full liberty to work the work of decomposition. A far better plan would be, to cleanse the surface of the plates by means of acid, and then tin them all over; the process would not be very expensive. It has frequently been remarked that carriage springs in action yield more in wet weather than in dry. This may be very easily accounted for. The plates act by rubbing against each other's surfaces. In dry weather there is much friction by reason of the rust; but when the rain gets in between the plates, it serves to lubricate them.

The names given to carriage springs are numerous; but the simple forms are few, the greater part of the varieties being combinations of the simple ones. The simple forms are,—the straight spring, either single or double,—the elliptic formed spring, either single or double,—the regular curved spring, either single or double,—the reverse curved spring, either single or double,—and the spiral spring.

* The mere polishing the blue colour off a watch spring is sufficient to destroy its perfect action.

Examples of the straight spring may be found in the modern Phaeton, the Tilbury, and in the Curricle pole, where it is suspended from the steel bar over the horses' backs. The technical name is "Single Elbow Spring."

Examples of the double straight spring may be found in most two-wheeled carriages, where it is fixed across the axle at right angles. It is also used in the Omnibus, the Stage-coach, the Cabriolet, Dennet, Stanhope, Tilbury, and many other vehicles. The technical name is "Double Elbow Spring." A similar spring of one plate is also used as a splintre for horses to draw from.

The elliptic spring is used single, in what are called under-spring carriages, where the spring rests on the axle, and is connected with the frame-work by means of a dumb or imitation spring so as to form a double or complete ellipse. This is technically called an "Under Spring."

When four of these springs are hinged together in pairs so as to form perfect ellipses, they form four springs all working together. They are used principally for four-wheeled carriages without perches. Eight springs or four ellipses constitute a set. The technical name is "Nut-cracker Spring."

The regular curved single spring is in form generally, two-thirds of a circle lengthened out into a tangent, which serves as a base to fix it by, in an upright position. A leathern brace is suspended from it to carry the body or weight. Its general figure has caused it to acquire the technical name of "C Spring."

The regular double curved spring is now rarely used. Its form is three-fourths of a circle, fixed with the open space

upwards, a leathern brace being suspended from the two points to carry the body or weight between them. This spring is of double weight without any corresponding advantage, and to get sufficient length for play, requires an unusually long carriage. The technical name is "Double C Spring."

Examples of the single reverse-curved spring may be found in the old-fashioned Phaeton fore springs, in the fore springs of the Tilbury, and also of the Cabriolet. They were also used formerly as "body springs" to fix to the body in lieu of suspension brackets or loops. Ere C Springs were used, they were applied as upright springs to Coaches and Chariots, under the technical name of "S Springs;" in which case, leathern braces were attached to them, and they were supported by a bracket or buttress of iron called the "Spring Stay." The "Whip Spring," which succeeded them, and has yet only been partially superseded by the C Spring, was used in the same way.

The hind springs of Mr. Russell's steam carriage are the only example of the double reversed curve, fixed by the centre, and acting in opposite directions.

The examples of the spiral spring in old-fashioned carriages are found interposed between the leathern braces, serving as a sort of elastic bracket to keep them apart, so that they lengthen and shorten in the working. The other example is in the spring cushions of modern carriages.

Both these springs are alike defective, on two accounts. In the first place, the brace spiral, instead of being cylindrical in form, was a double cone, largest at the centre; and next, being screwed firmly at the ends by screws, it could not play without straining the metal. The cushion spring

also is a double cone, with the smallest part in the middle. These are also fastened between two frames covered with strained canvass, to which the ends are firmly sewed, and consequently they cannot act without straining the metal. These springs are not made of steel wire, which is found to break, but of iron wire, which, owing to its toughness, will bear the strain of its metal for a long time without breaking. But the ultimate consequence is, that after a period they require to be renewed.

To understand the principle on which a spiral spring acts, we must imagine it stretched out into a straight line. If it were then suspended by the centre, the two ends would play freely beneath weights placed on them adapted to their strength. But if the spring were suspended firmly by the two ends at fixed points, and the same weight were placed in the centre, it would not play at all. If sufficient weight were added, and concussion employed, it would break down. When the straight rod is turned into a spiral, its mode of action is not altered; it continues to act in the direction of its length, though that length is laid in a coil. It is therefore of as much importance that the ends of a spiral should be left free, as the ends of a straight spring; and if they be fixed and sufficient force applied, they must break. And it is not sufficient that the ends be free to ensure a perfect action: the spiral should be regular and of a cylindrical form, or the strain would not be on all parts alike. The child's spiral spring-gun is a familiar illustration of the mode in which this spring can best act.

The combinations of springs used in carriages to which technical names have been given are eight in number.

The Nutcracker,
Telegraph,
Old Phaeton,
Tilbury,
Modern Phaeton or Mail,
Dennet,
Cabriolet,
Underspring with dumb iron.

Nutcracker Springs, as before described, are a combination of ellipses.

Telegraph Springs are a combination of straight springs, eight in number when used for four-wheeled carriages, four at each end. Two springs are fixed longitudinally on the framework, and two transverse ones are suspended from them by shackles: on the latter the weight rests. From the small space they occupy, they are constantly used in stage-coaches. They are not easy without a great weight on them; but they have the advantage that the body is thus placed two removes from the concussion. The two-wheeled carriage called a Stanhope is suspended on four of these springs.

The old Phaeton was an example of the combination of the upright C, or S, or whip springs, with leathern braces behind, and two pairs of single elbow or reverse-curved springs before. In this carriage there are six springs altogether.

The Tilbury Springs are a combination of two single elbow springs attached to the body, suspended by leathern braces to a straight transverse spring behind. In front, two single elbow springs attached to the body serve to

suspend it from the shafts by a short leathern brace. In addition to these springs, double elbow springs are sometimes interposed between the axle and the shafts. In this case, seven springs are used. This mode of hanging is unscientific, inconvenient, and unsightly, besides possessing considerable extra weight.

The modern Phaeton Springs are a combination of the Tilbury and Telegraph springs, the hinder part being suspended like the hind part of a Tilbury, and the fore part like a stage-coach. Seven springs are used in it.

The Dennet Springs are a combination of three straight springs, two of them being placed across an axle at right angles, and the third suspended from them by shackles behind. The shafts are attached to the fore part of the springs, as in the street Cabs.

The Cabriolet Springs are a combination of C springs behind, with leathern braces, and two reverse-curved springs suspended from the shafts before. Two double elbow springs are also interposed between the shafts and the axle. This is altogether very heavy, owing to the size of the springs.

The Under-spring Carriage Springs are a combination of C springs and leathern braces above the framing, and single elliptic springs and dumb irons upon the axles beneath it.

The last combination is the most effective which has yet been discovered for producing the minimum of concussion or motion to the passengers; but the weight is so considerable, that of late many persons prefer to have carriages suspended on the double elliptic springs alone.

When carriages were first used, roads and pavements were so rough, that long leathern braces attached to upright springs were the only available means of avoiding concussion; but Macadamisation in modern times has contrived to make streets and roads as level as bowling greens, so that the elliptic springs are now nearly as easy as springs and braces formerly were. The modern circular spring, with its long brace, yields a universal motion before, behind, upwards, downwards, and sideways; and therefore, weight apart, it is the best. Elliptic springs only yield an up and down motion. Telegraph springs, by means of the swinging shackles which connect them together, have to a small extent a universal motion; but elbow springs, like the double elliptic, are confined to a vertical action.

The C spring and long brace is the best for the rider, but not so well for the horse; for although an elastic carriage of equal weight with a non-elastic one is far the easiest to draw, still that is when the elasticity does not cause much momentum, as is the case when a heavy body swings loosely on leathern braces.

It has been remarked that accidents from breakage rarely occur in C springs, but frequently in elliptic and double elbow springs. And moreover, these accidents, contrary to apparent probability, happen more commonly with light carriages than with heavy ones. The reason, however, is an obvious one. The elliptic and elbow springs are firmly bolted both to the axle and the framework. Their strength lies in the direction of the downward pressure, and a heavy framework always keeps them to their work in that direction. But light carriages, after a violent

concussion downwards, experience as violent a rebound upwards, when all the weight is thrown on one or at most two plates, instead of the whole, and of course the liability to break is increased. To diminish this chance as much as possible these springs are in the best carriages not bolted through their substance, but fixed with clips, which avoid the necessity for drilling holes in them. The clips are however very unsightly, and a better mode is, to drill them and screw the nuts down on a strong short plate opposed to the usual strain. Sometimes these springs break because the end hinge bolt holes are not truly bored. But carriages will not be perfect till springs shall be devised, which, without causing momentum, shall yield a universal motion, acting at the same time by suspension and also by pressure, resisting an upward or lateral rebound as well as a downward concussion, and capable of adjustment to light and heavy weights. When a wheel revolves, the obstacles it encounters communicate a shock in the direction of the length of the carriage, as well as upwards and diagonally.

The combinations of springs most commonly used have been described, but out of the simple forms a great number of changes of combinations may be devised.

CHAPTER IX.

Iron-work.——Cranes.—Perch Plates.—Loops.—Stays.—Plates.—Hoops.—Clips.—Bolts—Steps—Treads—Joints—Shackles—Jacks.—Qualities of Iron—Plated Work.—Beading—Lamps—Dress Lamps—Wax Candles—Oil Lamps for travelling—Argand Lamps.—Cochrane's Patent Lamps—Principles of Combustion.

In addition to the axles and springs, a large quantity of expensive iron-work is used in carriages; the principal cause of which expense is not the material, but the highly skilled labour which is necessary in preparing it.

The most expensive articles are iron Perches or cranes, the use of which is to allow the fore wheels to turn beneath them, to gain space in narrow streets. But such weighty and unsightly encumbrances are no longer necessary, as roads and streets are now made wide enough for convenience, unlike the mere lanes and bridle-paths of former days.

The articles next in expense are the long broad plates riveted to perches on either side, to prevent them from breaking by the strain of an unequal surface of ground, as the curved form of the perch cuts the grain of the timber across and disposes it to break with facility. These plates being exposed to view, as forming a conspicuous line in the carriage, are necessarily very nicely

wrought. Another plate, of rougher construction, is bolted to the bottom of the perch.

The article next in expense is the Wheel Plate, or circular iron on which the fore carriage turns. This also requires very accurate workmanship.

The Loops, which serve to suspend the body, require exceeding good workmanship, for they are curved in many opposite directions, are tapered, and irregularly formed every way, yet requiring to have bearing bolts accurately adjusted, and sundry contrivances for affixing iron-work to them, and all this without a single straight side for the maker to work from. They are samples of great mechanical skill and dexterity of hand.

Other carriage iron work generally is divided into Stays, Plates, Hoops, Clips, Bolts, Steps, Treads, Joints, Shackles, Jacks.

Stays, are iron brackets of various forms, bolted by their extremities to such parts as they are intended to sustain, without bearing throughout their whole length.

Plates, are irons which bear throughout their length and breadth on the part they are intended to strengthen, and to which they are fastened by bolts, screws, or rivets.

Hoops, are flat strips of iron riveted or welded together for the purpose of securing timbers together side by side.

Clips, are a kind of open hoops, the ends of which are formed into screw bolts to take nuts. The object they are used for is to screw springs and axles in their places without the necessity of drilling holes through their substance.

Bolts, are cylindrical pieces of iron of various sizes,

one end of which is flattened out to form a head, and the other is formed into a screw to receive a nut. The use to which they are applied, is to secure the iron-work and heavy framework.

Steps may be single, double, or treble. In the two latter cases, they are called folding steps, and may be made to shut inside the body or outside. Outside, they are frequently very unsightly; and if they be well managed, they do not incommode the sitters inside.

Treads, are small single steps a few inches square, fixed for the most part on a single iron stem.

Joints, are jointed iron stays made in the form of the letter S, and serve to keep the leathern heads or hoods of open carriages stretched firmly out, when shade or shelter is required.

Shackles, are iron staples which serve to receive the leathern suspension braces on the springs, and also to couple springs together.

Jacks, are small windlaces which serve to receive the ends of the leathern suspension braces after passing around the backs of the springs. By means of a wrench or winch handle, the jack may be wound up or let down so as to shorten or lengthen the brace.

The variety of small articles of iron-work used in carriages would occupy a catalogue merely to enumerate, and they are not of material importance enough to dwell upon, more especially as many of them are used in other branches of art as well as carriage building. The greatest improvement in minor articles for carriages which has taken place of late years is in the door hinges, which,

instead of projecting from the panel, and giving admission to water, and being exposed to rust and rot, as formerly, are now entirely concealed beneath the surface by being made to turn upon excentric centres. Yet, strange to say, these hinges were invented many years before they were brought into use; and this was owing partly to the inaccuracy of their construction, and partly to the skill it was necessary for the workmen to acquire, in order to ensure their accurate insertion. They, however, require very large timber framings to insert them in.

For the security of carriage iron-work, two qualities are required in the metal,—toughness and rigidity. If it be not tough and fibrous, it will snap short; and if it be not rigid, great additional thickness, and consequently weight, will be required to prevent it from bending. For this reason it would be advantageous to use spring-steel in lieu of iron for many portions of the work, and especially the plates, as its superior rigidity would enable the work to be executed with greater lightness, and the lesser amount of weight would partly compensate for the difference in value of the material.

Two modes are resorted to in order to secure the iron and steel work of carriages from rusting; viz. covering their surfaces with paint, or with metal not subject to rust. Steel springs are always painted; though there would be no difficulty in plating them—and it would be a far better mode of securing them against rust, for those to whom expense were not an objection. Carriage iron-work is always plated when it is wished to make it ornamental,—in which case it is first covered with a

coat of tin laid on by means of a soldering iron with rosin and a small portion of sal-ammoniac, which promotes union between the two metals. The tin being smoothed, a portion of silver or brass rolled exceedingly thin is laid on, and by means of the soldering iron it is made to adhere to the tin; more of the silver is then added to join the first by the edges, till the whole surface is covered. It is then burnished and polished by means of proper tools. All articles of iron requiring to be covered with silver are treated in the same way; small articles of ornament in brass, which do not require strength, are cut in solid metal, as it is cheaper by the saving in labour; but for heavy articles, the weight of metal would much enhance the price, supposing strength not to be required. Wheel-nave hoops, axle-tree caps, loops, brace buckles, check rings, and door handles, are covered with brass or silver in highly-ornamented carriages; in ordinary ones, the loops and wheel-nave hoops are painted.

The beading which is used to cover seams and joints, is of three kinds: brass, copper, and plated copper. It is formed of stripes of rolled metal drawn into a semicircular or angular form by means of a die, the hollow space being filled with solder, into which small pins of pointed wire are fixed to attach it by. The brass beading is polished; the copper is painted, for which purpose the surface is roughened. As the quantity of beading used is very considerable, the labour of silvering by means of a soldering iron would be too great, and therefore the plated or silvered beading is prepared from metal silvered in the sheet. The process is very simple.—A bar of

copper being made flat, a bar of silver of the requisite size is united to it by heat. They are then passed through the rolls together, and occasionally annealed in the fire till the requisite thickness is attained, the two metals spreading equally. This kind of metal is much used in the manufacture of carriage lamps.

Several kinds of Lamps are used in carriages, both as regards principle of construction, as well as form and ornament. In the simplest kind, the light is furnished by the combustion of wax candles, which are contained in tin tubes, through a hole in the upper part of which the wick passes, the candle being pressed upwards as fast as it consumes, by a spiral spring. In what are called dress carriages, when the lamps are very ornamental, the sides being composed principally of glass, wax candles are always used on account of their superior cleanliness, though their light is inferior to oil.

Lamps used for the purpose of travelling are mostly used with oil. Indeed, the proper meaning of the word lamp is, a vehicle in which oil may be burnt by means of a wick. But amongst carriage constructors, what is commonly understood by a lamp is, the frame and glass which shelters the light from the weather, without regard to the light itself: this is, properly speaking, the lanthorn or guard. Dress lamps are of a circular form, but travelling lamps are square, and so contrived with slides or shutters, that they may be blind by day for the greater security of the glass, and only show their interior by night. The lamp itself is commonly a round wick of the most ordinary kind, though sometimes flat for the sake of spreading the flame. Re-

flectors of many kinds are used in every variety of carriage lamps, formed of silvered metal highly burnished. Attempts have been made to use the Argand lamp with a current of air through the wick, but hitherto without sufficient success to bring them into general use, as it is found that they are liable to be suddenly extinguished by violent draughts of wind. There is, however, little doubt that this will ultimately be accomplished, when the philosophical principles of combustion and the regulation of the draught shall be better understood. There are, however, some difficulties to be overcome.

By a common lamp, is understood one that feeds the wick with oil by capillary attraction, the column of oil being below the level of the flame. An Argand lamp, on the contrary, has a column of oil considerably above the level of the flame, and constantly pressing upwards to it like a fountain. The motion of a carriage has a tendency to make the oil at times flow too rapidly, and extinguish the flame, and sometimes also to cause too sudden a gush of air up the central tube, which blows away the flame from the wick. And when these difficulties are overcome by ingenuity, the lamps become too complicated for the skill of the generality of servants into whose charge they are committed. This is the greatest difficulty of all, but, fortunately, it is one which will be overcome with the progress of time. The light yielded by the Argand lamp is so infinitely superior to that of candles, or any other light save gas, that it is now universally used in houses by all who can afford it, and of course the skill to trim it must exist within the walls of dwellings. To transfer this

skill to the stable and coach-house cannot be a matter of insurmountable difficulty.

The principle of constructing an Argand lamp so that it may regulate its own air-draught, is set forth by Lord Cochrane in one of his patents. It is to divide the lamp into three chambers,—one in the centre which contains the reflectors and light, surrounded by the chimney glass, and having a communication with the other two. A chamber above this receives the top of the chimney glass, and is pierced with holes at the sides to permit the egress of the heated air and the ingress of the atmospheric air. From this chamber a tube or tubes communicate with the lower chamber, into which the air-tube of the burner descends, and thus furnishes a regulated supply of air. It is evident that by this process the air rushing in must be regulated by the air rushing out, and *vice versâ*.

The flame of a lamp is not produced by oil or tallow alone; it requires the oxygen of the atmosphere to mingle with it. Without a supply of oxygen it would be extinguished; and herein consists the advantage of the Argand lamp in furnishing atmospheric air in the centre of a flame. The flame arising from a thick wick, either round or flat, is hollow; *i.e.* it is a film of light like a bladder, and not continuous, the inner portion of the bladder being filled with gas.

It is well known that if the flames of two candles be brought in contact, they will produce a greater intensity of light than if they be burned separately. Upon this principle what are technically termed "cobblers' candles" are made. For the same reason, lamps are sometimes made

to burn two or three wicks, placed just so far apart that the flames may come in contact. This is an approximation to the Argand principle, by admitting air between them. But there is one difficulty attending them, viz. the regulating the wicks all to an equal height, which would be considerable, unless the lamp were so contrived that all could be regulated by one movement. If this difficulty should be overcome, a very excellent lamp might be made by placing four wicks in a square.

It is too early yet to look forward to the time when portable gas will be burnt in carriage lamps, at least for anything but town use. But the time will come when gas will be kept at inns as an article of consumption for travellers, as commonly as axle oil or grease.

CHAPTER X.

Construction of a Carriage.—Length.—Height of Wheels.—Dishing of Wheels.—Axle Arms.—Springs.—Lock of Front Wheels.—Splinter Bar.—Timber.—Construction of a Body.—Painting.—Iron-work.—Trimming.—Carriage Frame-work and Iron-work.—Leather Braces.—Hanging the Body.—Dress Carriage.—Seat and Hammer-cloth.—Hand Standard.—Open and Close Carriages.

In commencing the construction of a carriage there are several points to consider:—first, the purpose to which it is to be applied; and next, the amount of power which is to be applied to draw it;—in other words, the size and strength of the horses. It is a generally-received opinion, that the shorter the carriage, the lighter it will run. In surmounting the angle of a ridge, this is undoubtedly the case; but on a straight hill side or on level ground, a long carriage and a short one must be alike in friction, provided the total amount of weight and all other circumstances be equally balanced.

The next consideration is the height of the wheels. On level ground, a horse will draw a vehicle with the greatest facility when the centre of the wheel is a trifle lower than the point of draught, viz. the point where the traces are affixed to the collar; but this in practice would be found inconvenient, inasmuch as a rider would be unable to enter the vehicle save from behind, and moreover the height of

the axle would necessitate a corresponding and inconvenient height in the rider's seat. For this reason, the total height of the wheels of two-wheeled vehicles is usually made to vary from three feet to four feet six inches. It must be borne in mind, that a low wheel on a very level road,—a rail-road, for example,—may be more efficient than a higher wheel on a rough and uneven road. But on the same road and with an equal load, the high wheel is that which requires the smallest amount of power to turn it.

It would be a desirable thing that the wheels of four-wheeled carriages should all be of equal height, in order that the friction and power might be equal, but this is prevented by the existing mode of construction, which has prescribed one only mode of making the lock or turn. It is evident, therefore, that the height of the fore wheels must be regulated by the height at which the body hangs, so that the wheel may pass beneath it without striking when the springs play. In practice, this height varies from two feet to three feet eight inches, according to the kind of carriage the wheels are intended for. The hind wheels vary from three feet to four feet eight inches.

The next point is the dishing of the wheel, which is necessary for the four purposes of—strength—to take the strain off the nuts,—also to throw off the mud, and prevent it from clogging either the wheel or body,—and also to give greater space between the wheels upwards, while the track is not increased. Whatever be the amount of the dishing or coning, which varies from an inch and a half up to two inches and a half, one rule should always be adhered to; viz. to make the lower spokes vertical with the horizontal plane,

both in the fore and hind wheels. The axles being then made both of a length, the hind wheels—if coned at the same angle—will follow in the track of the fore ones.

Long practice has verified the theory that a cylindrical arm will carry a wheel with less friction than a conical one; yet there are persons who from the dished form of the wheel extract the semblance of an argument in favour of a conical arm. A horizontal axle, it is clear, runs with less friction than one which dips; but with a dished wheel it is necessary to have a pitched or dipping arm. If therefore the arm were made conical so that the bottom of it might become horizontal, it is clear that a dished wheel would not be liable to run hard against the shoulder collar. The argument seems plausible, but it is fallacious, inasmuch as the curving of the arm would reduce the front bearing surface so much, that the oil would be squeezed out, and it would run dry. The action would thus be unequal, and the total amount of friction would be increased.

The next point to settle is the form, combination, and proportions of the springs. Springs which are laid upon the axle at right angles have to carry all the weight of the carriage save only the wheels and axles. Where other springs are used in addition, it is not necessary that the axle springs should have much play: it is sufficient if they vibrate slightly so as to intercept the concussion from the road. The strength of the springs ought to be adjusted to the weight they are intended to carry, for it is evident that if they be made sufficiently elastic for the weight of six persons, and only three enter the carriage, the springs will be found too hard. Yet this disadvantage carriages

labour under, that the load is sometimes made to vary from two persons to six or seven, and a large quantity of luggage. In this case, the only remedy is to make the springs sufficiently strong to carry the greatest weight which is likely to be put upon them, and then, if their hardness be complained of with a light load, to add ballast in the shape of leaden weights till they be brought down to their work. It is probable that in time carriage springs will be used, capable of adjustment according as their load be light or heavy; but meanwhile there is no better remedy than ballast, for carriages intended to carry unequal weights. Light carriages are never so easy to ride in as heavy ones, even when the springs are proportionately adjusted; for the concussion of a rough road takes more effect on a light carriage in causing rebound, than it does on a heavy one.

The next consideration in a four-wheeled carriage is the lock of the front wheels, which must of course depend on the length of the axles, or width the wheels are apart. This in a full-sized carriage is from four feet six inches to five feet. The fore wheels will therefore strike the perch at the distance of two feet three or six inches from the perch bolt. The body therefore must be so hanged that it may not approach within eight or ten inches of this spot, in order to prevent it from striking the front wheel when on the lock.

The height of the splintre bar from the ground should fall on a straight line drawn from the horse's shoulder to the centre of the hind wheel. This, however, is not always convenient in practice, as the fore wheels regulate the height of the framing of the under carriage, to which the

splinter bar is affixed. The distance of the splinter bar from the central pin or perch bolt is regulated by the size of the wheels, and the projection of the driving-seat foot-board.

The ash timber of which carriages are built is allowed to lie some time after falling. It is then cut by hand into planks of different thicknesses, from six inches to an inch and a half, which are piled one on another, with flat sticks between, and left to dry a sufficient time. As the forms of carriage timbers are for the most part irregular, machinery has not yet been introduced for the purpose of sawing them.

When the plank is dry, the softer portions are set apart for body work, and the tougher for carriage work. The different portions being marked out on the planks by patterns, they are cut out at the saw-pit or saw-bench, care being taken to adapt the circular shapes to the natural curves of the wood. In this state the timber mostly undergoes another drying process. The chariot body maker having sorted out the right number of pieces, planes a flat side to each of them, from which all the other sides, whether straight or circular, are worked. They are then framed and [illegible] together; after which the grooves are formed for the panels and rebates for the floor, and then the carver beads and carves the various parts. Previous to being fitted in, some of the panels have canvass glued firmly on their backs, and when in their places, blocks are glued all round their inside edges, to fix them firmly to the framing. Before the upper panels are put in, the roof is nailed on, and all the joints stuck over with glued blocks

inside. The roof is then painted, and a hide of undressed leather is strained on wet, nailed, and left to shrink. The upper panels are then put on, united together at the corners, and blocked. Such panels as require much bending are wetted on one side, and held over a flame or heated surface on the other. In this mode the thin board which covers the sword case is bent to its shape. Formerly it was the custom to cover the roof, upper panels, and sword-case, all with a single piece of leather; but now it is only considered necessary to cover the roof, a piece of fine linen being glued over the surface of the sword-case board, which also has canvass glued inside. The doors are then made and hinged, and the hollow spaces intended to hold the glasses and blinds are covered in with thin boards; and the whole being complete, the body is given in charge to the painter, who colours it over with a paint composed of white lead and litharge outside, and also paints the whole of the glued canvass inside with coarse colour, to prevent damp from acting on it. Coats after coats of white lead and yellow ochre, to the number of six or seven, are then applied as fast as they can be laid on; and then they are left for two or three weeks, if there be time, to harden. When hard, the whole is rubbed down with pumice stone and water to a smooth surface, the grain of the wood being entirely covered and hidden. One or two coats of white or lead colour are then applied, which are afterwards smoothed with sand paper, and then one or two coats of green, brown, or yellow, or whatever colour is intended, are laid on, till the whole appears one homogeneous surface. The framings are then blacked; and when dry, the clearest copal body var-

nish is applied, to the number of six coats, over the coloured parts; and several coats of black japan are applied to the roof, upper panels, and sword case, ending with a coat or two of varnish. The whole is then suffered to harden. The process of polishing the varnish is put off as long as possible. The loops and other iron work are then fitted, filed, and japanned black, if they be not intended to be plated with silver or brass.

The body then goes to the trimmer or liner, and the inside is either caned or nailed over with strained girth web. Canvass is then nailed over some of the uneven portions, and wadded with tow. Certain parts, such as the doors, pillars, and roof, are covered with cloth; and valances of fluted cloth are made to hang from the seat edge to the flooring. Lace composed of silk, worsted, or of both combined, is applied in various ways as a binding. It is divided into three qualities:—broad, which is about two inches in width; posting lace, which is half an inch broad, and serves to cover rows of tack heads; and seaming lace, which is applied to cover coarsely sewn edges. It was formerly customary to use cloth only as a lining; but now, the seat cushions, and those for the back and sides, are covered with silk or morocco. The back and side cushions are stuffed with horsehair only, as the pressure is not great upon them, and the back of them is only canvass, as they are fixed in their places. But the seat cushions being moveable, they are covered with cloth on one side, and silk or morocco on the other. Being subject to much pressure, they are made firm round the edges with tow and flocks, horsehair being applied at the top. To make the cush-

ions more firm, they have strings tied at various parts through their thickness, the strings being hidden by tufts of silk or worsted. The folding steps are then trimmed with carpet and morocco, and a carpet is fitted to the bottom or floor, when the body is ready to place on the carriage, after the plater has put on the beads, door handles, and check brace rings, and any other ornamental work which may be required.

The process with the carriage part is simpler. The workman first planes a flat side to the perch, and then tapers it narrower behind than before. He then works up the top and bottom curves, or some portions of them, and frames on the front and hind spring beds. A pair of spreading wings are then fitted to the sides of the perch, and their hinder ends are framed through the hind spring bed. The hind axle-tree bed is then scarfed upon the top of the perch and wings, and is connected with the hind spring bed by two small framing pieces called nunters. At the fore end of the perch, a cross bed, called a horn bar, is scarfed on the perch, at the same distance from the fore spring bed as the hind axle bed is from the hind spring bed, viz. the length of the spring bearing—about fifteen inches. The horn bar is connected with the fore spring bed by the two spring blocks, which are either framed into them or scarfed down on them, and also by the looping piece, which is scarfed on the top of the perch. The perch and wings are then planed together to the proper curve, and the perch is taken to the smith, who fits and rivets on the side plates, which have ears at the ends to bolt them to the beds. The carver then does his work, by beading

the perch, wings, and beds, and rounding all the ends into form scrolls and volutes. A bottom plate with a drag hook riveted on it having been fitted to the perch, the hind framing is now put together, screw bolts securing the tenons and mortices, and light iron hoops fixing the wings to the perch, which are rebated to receive the perch plates. The hooping piece is then hooped in a similar way to the fore end of the perch, and the transom firmly bolted. The carriage is then turned bottom upwards, and the smith fits to it the wheel plate or turning iron, across which runs a broad plate the width and length of the fore spring bed. A similar broad plate runs across the hind spring bed. The hind axle is then fitted to the wings and perch, and let into its bed at the ends, where screw clips secure it, bolts passing through the perch and wings, sometimes through the perch alone. The carriage is again turned upwards, the wheel plate is raised on the top with carved wood, and a plate is riveted to the ends of the horn bar, when the springs are fitted to their blocks and bolted firmly down. Iron stays are bolted to the springs beneath the beds to render them still firmer. The footman's step, the tread steps for the coachman to mount by, and other iron-work, are then fixed, and the upper carriage is complete.

The under carriage is framed to the fore axle-tree bed, which is a very heavy piece of timber. Through this are framed the two futchells which receive the pole. The upper part of the axle-tree bed is covered with a strong plate to match the wheel plate. A circular piece of timber, called a sway bar, is bolted behind the axle-tree bed, and this also is plated beneath for security. In front is a

smaller piece of the same kind, and they both serve for the circumference of the wheel plate to rest on. The splintre bar is bolted to the fore end of the futchells, and secured by two branching stays, one at either end, connecting it with the axle-tree bed. As an additional security, iron stays are fitted to the bottoms of the futchells passing over the axle, which, in addition to bolts, is secured by screw clips at the ends, the same as the hind one.

The carriage here described is one without under-springs. Where under-springs are used, the mode of construction is the same, all but a few minutiæ, and a reduction of size in the material on account of the concussion being removed. The axles are in this case clipped to the under-springs, which hinge to the dumb-irons, cased with wood to make them resemble springs. This dumb-iron is bolted to the framing.

Those who are familiar with the subject will at once remark, that numerous minutiæ are omitted in this description; but to go through them would weary the reader as much as the writer, and serve no useful purpose, as it would scarcely serve to instruct one not previously familiar with the subject, how to construct a carriage. A general outline of the form and structure is all that the writer pretends to give.

The carriage being thus completed, the painter commences with it. Two coats of white-lead and litharge being applied, white or lead colour are again laid on to make a ground work, which is smoothed with sand paper. The colour it is intended to show is then laid on in two or three coats. After this, it is lined or picked out, together

with the wheels, which have undergone the same preparation. Three coats of copal varnish, of a tougher kind than that applied to the bodies, completes the operation.

The next point to attend to is the hanging braces, for which purpose the best and strongest leather is required. But few persons are capable of judging of the quality of leather without very long practice. The strongest material for the purpose of suspension, is untanned hide softened by friction and well saturated with oil or tallow. But this is elastic and very pervious to water. In this state it is very liable to stretch and lengthen. The motive for tanning leather, therefore, is to render it less pervious to water, less elastic and more solid. But the lime and the bark used in the process render the fibres of the hide brittle, and thus the weight which a strap of leather will sustain is many times less than that which a strap of the hide it has been prepared from would have sustained. But altogether the advantages are considered to be in favour of leather, though probably its appearance is a chief consideration. The best hide leather is that which is prepared in the West of England. Sometimes leather is undertanned; *i.e.* the interior of the hide remains in a gelatinous state, uncombined with the tanning principle. In that case, it is tough, but liable to stretch. Sometimes also, though not often, the hides lie too long in the pits, and being overtanned, lose much of their tenacity, while they gain in solidity. The best portion of the hide is what is called the butt, after the belly and neck parts have been rounded off. In preparing the braces, the butt is cut into straps slightly wider than the springs, viz. two inches and three-eighths, or

thereabouts. As many of these straps as are necessary for the weight they have to bear, are then put together, tapering from the hinder end to the other, which is turned over into a loop to receive the suspension bolt, the ends being tapered down one after the other with a spokeshave till the whole amalgamate neatly, forming at the double, a thickness from one inch upwards. They are then double sewed together with waxed hemp pointed with blunted needles instead of bristles, as the holes are all straight and pierced with an awl called a stabbing awl, made in the form of a spear head. In what are called the best braces, four rows of stitches are introduced, and the stitches are crowded together as many as possible in the space of an inch; which is a disadvantage, as the brace is thus nearly severed longitudinally. When the braces are finished, the hinder end of each is fastened to a small windlace called the jack, fixed to the bed of the spring, and capable of being wound up by a lever. The upper end of the brace is kept firm on the back of the spring by a shackle near the top, which clips it round. In ordinary carriages, these suspension braces, known as "Polignac braces," are admitted in the loops' heads by taking out the suspension bolts; but in ornamented carriages they are made shorter, and between them and the loops are introduced other braces, with large buckles, for the sake of effect.

From the spring heads to the centre of the body, small sewn straps called check braces hang in a low curve. They are to prevent the body from swinging too far fore and aft. From the perch to the bottom of the body, there is a

strong brace on each side, called the collar brace, the object of which is to resist any tendency of the body to turn over, and break the springs by a reverse action in case of violent concussion.

A very important point in the comfort and appearance of the carriage is the mode in which the body hangs. It should be so disposed between the four springs that the door pillars stand perpendicular. To accomplish this, the length of the loops and braces must be accurately adjusted, so that the centre of suspension may fall in the right place. Those who understand the operation can calculate it all from the drawing; those who do not, hang the body down by temporary loops, and get at the result by fourfold labour and expense. Of course it requires a correct eye to know when the body hangs in the right place.

When the carriage is intended for dress or town use, a Salisbury boot is fixed on carved blocks on the front beds. This is a kind of egg-shaped trunk, with one end open, and the other flattened diagonally to form a base. It is a heavy frame of most expensive make, partly close and partly open railed and covered all over with black japanned leather. On the fore part of it a coachman's foot-board is fixed, painted and varnished the colour of the carriage. On two horns which project upwards from the boot are fixed two branching stays to take the coachman's seat,—a kind of wooden frame covered with canvass and baize, and stuffed with straw, higher at the ends than in the middle, to give the coachman a firmer seat. This coarse-looking frame is covered by the hammer-cloth, the colour of which sometimes harmonises with and sometimes forms an agreeable

contrast to that of the paint. It is made of very strong cloth stiffened with tarpaulin, canvass, and paste, and contrived to hang in graceful massy folds. The upper edge has a single row of broad lace round it; the lower edge is made somewhat to resemble an architectural basement, by three rows of broad lace, or two rows of lace and one of deep heavy fringe. The central compartment of the end folds, usually receives a crest done in silver, brass, ivory, or embroidery.

The hind standards and footman's holders being affixed, as well as the lamps, and the wheels being oiled and regulated, the carriage is ready for use.

With little difference such is the process through which all carriages pass, from their first entrance into the coachmaker's factory in the shape of material, till they leave it in their most perfect condition. The varieties of carriages are every day increasing as far as regards form, though the general principles of construction remain the same. In four-wheeled carriages there is one great distinction to be made—those constructed with braces, and those without; *i.e.* those bolted to the springs firmly, and those hanging loosely from them. The carriages without braces are the roughest, but also the lightest and least costly. There is another distinction to be made; carriages which are open, or made to open occasionally, and which are provided with doors, must necessarily be heavier than close carriages, as the bottom must be made strong enough to sustain its weight and that of the passengers without any other framing. A Landau, for example, is much heavier than a Coach, because it is necessary to sustain the bottom with

heavy iron plates, in order that it may not alter its form when the head is open, and thus prevent the doors from opening and shutting. A Phaeton also may be made much lighter than a Barouche or Britzschka, because the two latter must have bottom plates, and the former requires none.

CHAPTER XI.

Invention.——Derivation of Carriages mostly Foreign.—Original Inventions and Improvements.—English Artists. Patent Rights.—Continental Artists.—Processes of Improvement.—Theory and Practice. Genius and Invention.—Wollaston.—Brindley. Watt.—Babbage.—Analysis of the Qualities developing Invention.—Difficulties of Inventors.—Expense of Patents. Jealousy of Rivals. Combination of Carriage Forms and Proportions. Taste in Design.—Drawing. Variety of Qualities necessary to conduct a Carriage Manufactory.

English carriage constructors are certainly not an inventive race, if we allow that the names by which carriages are known are indicative of their origin. *Coach* is derived from the Hungarian *Kotsee*; *Chariot* is French; *Landau* is German; *Barouche* and *Britzschka* are the same; *Vis-à-vis* is French; *Cabriolet* is French; *Chaise* is French; *Droitzschka* is German. Even the English *Curricle* has a Latinized name; and the Phaeton takes its designation from the heathen mythology. Whiskey, Gig, Stanhope, Tilbury, Dennet, Buggy, and Jaunting Car, are our only native names; and the first six are only variations of the same thing.

But mere invention, mere original conception, does not constitute excellence; and if foreigners may fairly lay claim to the greatest originality, English artists have the merit, perhaps still more important, of gradually improving

the original designs, and so contriving all the details, that, in their state of comparative excellence, the carriages can scarcely be recognised as constructions of the same principle as their models. In order to verify this assertion, let any man compare one of the German Britzschkas brought over to England when peace was last proclaimed, with one of the best constructed English Britzschkas of the present day.

That English artists are not remarkable for the invention of new carriages, is no proof of their want of the talent of invention. They have invention in abundance, if there were sufficient motives to call it forth; but the fact is, that invention is a matter but poorly paid for, unless it can be effectually secured by patent right; and to make a patent profitable, several things are requisite:—first, to produce an article for which there is a considerable demand; secondly, that it be an article of such a nature that it cannot be pirated under the form of what are called "improvements;" and thirdly, that the material of which it is composed be in sufficient abundance to prevent its being monopolized. That considerable improvements may yet be made in wheel carriages, no sensible person will be hardy enough to deny; but very rare indeed are those for which a patent right could be maintained. English artists are mostly little more than merchants in their mode of doing business; they cannot afford to lose time, and their principal object is to make as large an annual return as possible, and as large a profit as possible on that return. Continental artists are very commonly enthusiastic lovers of their art; they try to improve it from liking for it, and

when they fail, it is mostly from want of efficient workmen to further their designs. The demand with them is not sufficient to make every branch of their art a manufacture. In England, on the contrary, the manufacture of carriages is a work of many trades, and thus greater skill is produced in manipulation. But few carriage builders care to introduce anything new. If chance brings in a new fashion, competition is aroused, and does not subside till excellence or something approaching thereunto be attained. A foreign artist has mostly abundance of leisure time for his invention to work; but if an English artist attempts to invent, his trade stops, and he will probably be designated for his pains by the contemptuous epithet of "schemer," even though his genius be that of a Watt. The ordinary measure of talent is held to be success, *i.e.* the acquisition of property; though it is quite clear, the qualities which ensure success are not always those which tend to produce excellence or improvement in carriages more than in other arts. The inventor may produce, but it is for the most part the mere merchant or tradesman who profits by the inventions. Carriages are made to sell, as plays are written to fill theatres; and the English carriage builder takes a French or German carriage to improve upon, because it saves his time and trouble, just as the English play writer translates a French play to save the labour of his brains. Improvements are rarely the voluntary production of English carriage builders; they are forced on them by the purchasers, first individuals, and then the mass, who desire, some mere novelty, others greater ease, and others a more rapid rate of motion. Almost all the changes and improvements

in carriages may be traced in their origin to the carriage users, and not to the carriage builders. The carriage builders do not lead, but they have always the means of pressing talent enough into their service, whenever a sufficient demand offers them a remunerating return. Coaches were first invented on the Continent; but it was in England that they were improved into public stages, capable of being run ten miles and upwards per hour for days and weeks together.

This was not done at once, or by any one man: it was the combined result of numberless small improvements, forced on by the necessity of overcoming practical difficulties. Carriage builders have not been remarkable as a scientific body. They have been, strictly speaking, "practical men;" and as the knowledge they have gained by experience has not been carefully hoarded in books, carriage construction has remained a sort of occult matter, without any specific theory attached to it. Each one, as he is fresh initiated, gains his knowledge as he best can from verbal instruction or from a new series of experiments, and thus a considerable portion of his time must elapse ere he can have verified his judgment. Enough of this knowledge exists in various brains, which might suffice for the construction of a sound theory; but it would be a difficult operation to gather it together, for many petty feelings would be at work. In the mean time, all mention of theory save in derision is decried. By most experimentalists, the word *theory* is understood as synonymous with falsehood or absurdity,—as the very opposite of *practice*. It is clear that practice must be the ultimate verification of theory;

but every true practice must have a true theory belonging to it. The *theory* of a subject is the *science* or philosophy of that subject: practice is the positive knowledge or proof of the soundness of the theory. But as theories are more plentiful than practices, and as many of them are not verified, there are, of course, many false ones. On this ground, unscientific experimentalists have acquired the habit of regarding all theory as false; which is about as reasonable as it would be to assert that because falsehood exists in the world, all truth must therefore be extinct. This peculiarity is not confined to carriage building: engineering and architecture abound with it, and law and medicine are not wanting in it. The truth is, that human knowledge is only got together by small portions at a time, in the school of experiment; and when that knowledge is considerable in any one branch, a true and verified theory may be constructed from it. But when a great number of subjects have thus been analysed and theorised, it is comparatively easy to construct theories by analogy, on new subjects, by sound principles. Newton's theory of the universe was just as true when he first developed it in thought, as after he had verified it by calculation.

It is a common notion that a mechanical inventor must necessarily be a man of genius; but if the matter be analysed, it will be found that though inventors are occasionally men of genius, they are but rarely so. *Invention* in its ordinary sense, as the word implies, is the art of *finding out*. By *genius* is meant a species of creative power, like that of the poet, for example, in his highest state of excellence. Invention is of two kinds;—

one resulting from a quick habit of observation, which detects the applicability of various forms of matter to similar objects. Of this an example may be given in the case of Dr. Wollaston, who, in a hurried experiment, needing some lime, which was not at hand, suddenly cast his eye on his ivory paper-cutter, and with some scrapings from its surface accomplished his object. This quick habit of observation, when it goes to the production of beautiful forms, is akin to fancy. The other, and higher kind of invention, is that which results from bringing a theory into practice, — from first imagining a desirable result, and then bringing it to bear by the exercise of the judgment, and constant persevering efforts steadily directed through a long period of time. The names of Brindley and Watt, and in our own time, Babbage, are examples of this quality. When Brindley set to work upon canals, he did not create, — he merely formed the plan of levelling the surface of natural streams, by drawing off the water into new channels of sufficient depth, and then preventing the water from being wasted. The process of forming the locks was a continued series of mechanical contrivances, with purpose aforethought. When Mr. Watt first imagined the steam-engine, he did not invent the power of steam; that was known long before, and had existed from the time that fire and water existed. But he formed to himself the plan by which he hoped to realise the result of making steam an efficient human servant, through the agency of a perfect machine. The general idea of this machine existed in his mind long before he brought it into practice, and the slow process by which

this was accomplished is evidenced by the fact, that a prolongation of the term of his patent right was granted him by Act of Parliament, on the ground that he had not sufficient time to reap benefit from it. An anecdote told of Mr. Watt serves not only to prove this, but also his highminded philosophy, which was far beyond the miserable vanity of ordinary inventors, who aim at astonishing their fellows rather than instructing or benefiting them. After success had elevated Mr. Watt to the public eminence he so well deserved, a nobleman who dined in his company expressed himself in terms of wonder on what Mr. Watt had accomplished. Mr. Watt coolly remarked, "The Public only look on my success, and not on the intermediate failures and uncouth constructions which have served as steps to climb to the top of the ladder." Mr. Babbage also, in the remarkable volume published by him on the subject of Machinery, says distinctly in his preface,

"The present volume may be considered as one of the consequences that have resulted from the calculating engine, the construction of which I have been so long superintending. Having been induced during the last ten years to visit a considerable number of workshops and factories, both in England and on the Continent, for the purpose of making myself acquainted with the various resources of mechanical art, I was insensibly led to apply to them those principles of generalization to which my other pursuits had naturally given rise."

It is clear in this case, that the accuracy obtained in mathematical science led Mr. Babbage to conceive a

machine whereby the changes of figures might be multiplied *ad infinitum*. After this, in order to bring it to bear, he ransacked the stores of accumulated knowledge actually existing under the form of machinery.

The power of mechanical conception is very widely extended; it is a modification of the same power which composes romances: the magic horse in the fairy tale which turned and was guided by means of a pin in the neck, was a mechanical conception. If the same person who conceived that, had worked it out into practice, it would have been an evidence of genius; viz imagination discovering truth by some analogical inference. Invention, then, of the highest kind, must be composed of four qualities:—imagination to conceive a new and complicated machine, knowledge to gather materials, judgment to select and combine them, and perseverance, without wearying, till the result be obtained. There are few samples of mechanical invention like unto this. Those things which commonly go by the names of new inventions, are very frequently merely modifications of what has been done before: "Improvements" is the technical term.

The task a man has to go through, in conceiving, designing, perfecting, and patenting a complicated mechanical invention, is by no means inviting. Even when he possesses the hand to execute that which his head has contrived, only a portion of his difficulties are overcome. A first idea is fascinating, and apparently easy of execution. It is thought over again and again; all difficulties are apparently surmounted, and all obstacles re-

moved: it is, in the imagination of the inventor, perfect. He may perchance know how to draw; but if not, he must employ some one to make his drawings for him. In this case, to avoid the risk of piracy, he must previously take out his patent; *i. e.* he must incur an expense of from one hundred to one hundred and fifty pounds for a purpose whose success is uncertain, as it has not been experimentally verified. He may perhaps intend to take out his patent for England alone; in which case he is allowed only two months to specify or describe his invention, and make the necessary drawings for depositing in the public archives. If he can make up his mind to take out his patent for England and Scotland, he may have four months; if for Ireland also, he may have six months; but his expenses will be doubled or trebled, unless he can stretch his conscience, on the payment of the first fees, to swear that he intends a triple patent, for the sake of gaining the time, and afterwards changes his mind and takes a single patent. This species of conscience-stretching is very commonly practised.

Having secured his patent, our inventor sets his draughtsman to work, and with considerable difficulty—owing perhaps to want of clearness on the one side, and want of comprehension on the other—the drawings are made. Then follows the model; and ere that is completed, it is discovered that there occur unexpected difficulties in the material construction, which did not present themselves on paper. New contrivances must be resorted to, and the model is made and re-made many times over, at a considerable expense. It is at last completed—perhaps within a very few days of

the time allowed for depositing the specification, and fresh expenses are incurred by the necessity of paying highly, those whose business it is to work against time. When all is ready, the specification is deposited, and the inventor perhaps discovers that the title he has first taken will not cover his invention, on account of its being different from his first contemplation. The title therefore must be altered, and the fees paid over again; the first being an entire loss. He now sets to work to construct a full-sized sample of his invention, and all his patience is needed. He must take either first-rate or ordinary workmen. If he takes first-rate men, he must pay them very highly, because they must necessarily work more slowly at a process which they have to learn, than at one with which they are familiar; and in order to earn the same amount, they must be higher paid. If he takes ordinary workmen, his patience is still more severely tasked: he has to teach them how to work, without knowing how himself; he can only get at a result by numberless repetitions and by a great waste of time. At length his invention is in a state for practical trial. Up to this point all seems well; but practice soon discovers a defect, not perhaps in principle, but in detail. A second experiment is made without success, and many more follow ere the invention be completed, alike in principle and execution. Then begins the task of getting it before the public. Perhaps the inventor has been sanguine, and has attempted to introduce it to the public in an imperfect state, and the consequent failures have excited a prejudice unfavourable to his object. This prejudice has to be overcome by repeated and unceasing exertions; and at length,

perhaps, when half the period of the patent right has expired, the inventor begins to reap the fruits of his skill and industry. Public rumour is ever fond of exaggeration, and he is soon supposed to be realising a large fortune, though most likely he is only beginning to pay his expenses. Competition is then at work, and rivals, who have been at no expense or trouble, imitate his invention, or make just so much alteration in it, as they think necessary to evade his patent right. He goes to law with the pirates, and then perhaps makes the discovery that his title or specification is imperfect, and that he has been labouring for years to bring to perfection an invention from which he can reap no more pecuniary advantage than if he had confined himself to an ordinary trade, in which imitation alone is necessary.* If he be successful in a law-court against his piratical competitors, he may then chance to be amply repaid: but this is not a frequent case; and even when a man possesses imagination to conceive, the head to contrive, and the hand to execute, it is not an uncommon thing for the term of the patent-right to run out, ere an invention be reduced to general practice.

It is evident, therefore, that a man who possesses a good trade as a coach-maker has little inducement to embark in the perilous field of invention. His time is mostly taken

* By a late alteration in the law of patents this hardship has been in part amended, the inventor being permitted to disclaim any portion of his specification which makes against him, paying fees, of course. The want of a really efficient and simple patent law, protecting merit and punishing piracy, is a grievous hardship on one of the most deserving, and certainly not the least important classes of the community,—not the less important though usually needy,—others reaping the fruits of their exertions.

up with his ordinary business, and, unless under very peculiar circumstances, he has no leisure to study improvements. Those who have too little business to fill up their time are interested in producing new things, in order to attract public attention; but as their leisure is only at intervals, they rarely devote themselves to it. First ideas frequently originate with working men, who have not the means of putting them in practice unless in comparatively trifling improvements. It is mostly the interest of the established tradesman to discourage such things, as they interfere with their plans, and give them more trouble without extra profit. Thus, when under springs were first adapted to carriages, it was prophesied that they would be the ruin of coach-making, by making the carriages too durable. When the streets were Macadamised, the wheelwrights and coach-makers alike complained that it was destruction to their trade. It is the same in other things. The Manchester cotton spinner who has a mill and machinery already erected, does not feel very benevolently disposed towards an inventor who contrives new machinery of a better class, by which he can underwork him and take away his trade. It may be taken as a general rule, that new inventions are viewed with jealousy by all established tradesmen, on the grounds that they are an individual advantage, and not in the outset advantageous to the trade in general. Therefore they keep them down all in their power; and when they succeed, it is by the circumstance that they are valuable in themselves, and that the customers of the tradesmen insist on having them.

The advantages arising to an inventor of a new con-

struction of carriages are limited, and the disadvantages great. To secure a patent, it is necessary that the invention should be kept secret until the patent be sealed. Now, a carriage is a bulky machine, which cannot well be tried in secret, or made in secret: therefore the patent must be taken in risk and uncertainty. And even when all is accomplished, the demand is very limited. Carriage-keepers are not a numerous body, and they are usually more guided in their desire by a pleasing appearance than by mechanical excellence, and patents are not taken out for forms. The patents which are profitable to inventors, are for the inventions of machines to supersede human labour, and thus furnish manufactured goods at a cheaper rate to the consumer. The most ordinary man can judge of the wear of a pair of stockings, and will purchase them at a shilling more readily than at eighteen-pence, if they be of the same quality; but he will not so readily take to a newly-fashioned garment whose utility he has not tested by experience. Therefore he who invents a machine which enables one man to do the work of ten or twenty is certain of his gain; but not so he who invents a new commodity.

But the quality less necessary than many others to a fashionable coach-maker is, sound mechanical knowledge. Taste is the one requisite without which he cannot thrive, and which therefore constitutes his real business qualification. Taste is exhibited in form, colour, and proportion; and having this, he can employ other persons to fill up the details. The general mechanism of carriages does not vary, and the mechanism serves as a skeleton framework which is to be clothed according to fancy. Therefore, to

produce what is commonly called a new carriage is a work of composition, and not invention: it is a combination of already existing parts to form a new arrangement. The tasteful combiner may know nothing of the principle of his wheels or axles, or their due proportion of strength; but he has the wheelwright and engineer to take the responsibility for him. He may know nothing of the construction of springs, but the spring maker is at hand ready to calculate the requisite strength, according to an estimated weight, and if the weight should prove more than was expected, it is easy to apply an extra plate. He gives a general drawing of the framework, and a skilful workman knows how to apportion the scantling, and build it strongly together. A skilful smith makes his ornamental iron work to a given form, and takes all the responsibility of understanding and duly working the metal. He directs his painter what portions to put in colours, and what in ground colours, what to make conspicuous, and what to hide, what to lighten by lines, and what to leave heavy. The preparation of the colours, and their laying on, is the business of the painter alone. He directs the trimmer as to the general effect of the lining, and arranges the harmony of the colours, but the trimmer has to study the best mode of performing his work. The braces and other leather-work, are left to the skill of the workman, who is mostly left to select his own materials and apportion their strength; and the ornamental metal-work is the province of the plater, who is responsible for its wear. It is clear that, in addition to the possession of taste, it is almost absolutely necessary that a carriage constructor should know

how to draw, in order effectually to direct those whom he employs, and also to facilitate the purchasers who may employ him to build for them. If he possesses the facility of constructing simple models, it is still better.

To be a complete carriage constructor, a man ought to be familiar with all the branches before alluded to. But there are few mechanics of such universal knowledge, and still rarer is it that they combine that knowledge with taste. Even then it would be scarcely possible for a single individual to carry on a large business and do everything in his own factory. It would require an enormous capital and enormous premises, and moreover, very extensive mercantile knowledge and skill,—which last is based on qualities the direct opposites of those which nourish the faculty of taste. Mercantile skill depends on calculation: taste is a combination of imagination and observation. There are three modes in which carriage building on a large scale may be advantageously carried on:—first, by a single individual, whose business is only to combine parts, and who employs tradesmen for every separate branch; secondly, by a single individual, who employs responsible superintendents in every branch at high salaries; and thirdly, by a combination of partners, one possessing taste, another possessing mercantile knowledge, a third mechanical knowledge, a fourth inventive powers, and so on. This last mode would assuredly produce the most certain result, provided the partners possessed the necessary moral qualities to ensure the absence of suspicion, jealousy, and envy amongst themselves. If these evil qualities existed, they would destroy unanimity, and thus render the business unproductive, by preventing efficient arrangements.

It is probable that at a future time the workmen themselves will enter into some such combination, but it must be after a lapse of many years, as the principle of caste must first be eradicated amongst them, which is at present so fruitful a source of jealousy amongst the different branches. Ere that takes place, the increasing plenty of capital will probably induce many capitalists to vest property in carriage building, as they now do in house building, giving shares and salaries to men of undoubted skill and probity, in order to ensure efficiency and perseverance.

The present race of master carriage builders have not all been brought up to the business. Amongst the trade it is considered that the only legitimate carriage builder is he who has been brought up to the art of framing carriages or bodies. But as it has been shown that taste is the chief requisite, and as taste is not a necessary result of peculiar instruction, it follows that it must be had where it can be got. Thus, some carriage builders have been brought up as painters, others as harness-makers, others as smiths, others as wood-workers. Men who have been brought up to professions entirely unconnected with carriage building also occasionally embark in it. Of course, there are many varieties of skill and taste; but the public hitherto, except a very exclusive portion, have not been remarkable for the refinement of their taste in carriages: it is now rapidly growing up, and men of skill and taste combined, will probably meet with a much wider appreciation than they have been heretofore accustomed to.

In a philosophical classification of trades, carriage constructors may be designated as "manufacturing artists."

CHAPTER XII.

Carriage Artisans.——Handicraft Work.—Steam Labour but little used.—Skilled Workmen.—Modes of getting Work executed.—Piece Masters. Carriage Builders' Tradesmen.—Materials.—Various Workmen.—Body Makers.—Carriage Makers.—Carvers.—Smiths.—Trimmers.—Painters.—Brace and Harness Makers.—Sawyers.—Labourers.—Designers.—Draughtsmen.—Herald Painters. Axle-tree Makers.—Spring Makers.—Wheelwrights.—Lamp Makers.—Blind Makers.—Joiners.—Trunk Makers.—Turners.—Lace Makers.—Curriers.—Japanners.—Ivory Workers.—Platers.—Chasers.—Embroiderers. Trades' Unions.—Jealousy of Caste.

Carriage building still remains one of the arts to which steam and machinery have not been directly applied to facilitate construction and produce cheapness; though something has been done indirectly to reduce the price of the minor articles of metal-work entering into the construction, but, unfortunately, at the same time rendering their efficiency a matter of uncertainty. This is frequently the case with wholesale manufactures in which some portion is left to the workman's skill and choice. Few people like the trouble of examining minutely a large mass of small articles, and this an unprincipled workman takes advantage of. The reason that carriage building has kept aloof from the innovations of steam, probably is, that it is to a certain extent an art, like that of the statuary, and that the purchasers of carriages are not yet sufficiently nu-

merous to produce a regular manufacturing business; *i. e.* a repetition or copying of certain established forms. Carriages are articles of fashion and fancy, superadded to their utility, and changing fashions in a limited demand will not pay for the outlay of machinery. Besides, carriages are still in a state of progressive improvement—they are yet far from perfection, and it will not be till the demand increases so much as to make them objects of every-day necessity, like houses, that they will be made cheaper, by the introduction of steam and machinery, to supersede human labour in many of their processes. It may be said that stage coaches are numerous enough to employ a well-ordered factory, with steam and machinery; but whoever takes the trouble to examine them will find that, with the exception of the preparation of their crude iron and similar material, they are entirely the result of uncertain handicraft labour of various degree of skill. Undoubtedly large quantities of the drudgery of carriage construction might be performed by steam, and greatly to the advantage of the workmen; but the peculiar rules established amongst them, and the jealousy they naturally feel lest any unknown processes should have a tendency to diminish the amount of their earnings, will for many years prevent this, unless some determined speculator should embark in a wholesale carriage business, with an entirely new set of workmen, taken indiscriminately from all trades, unshackled by trade rules, and only selected for the single consideration of skill and capacity.

The workmen employed in the construction of first-rate carriages are all skilful men. The beauty, neatness, and

strength exhibited in them could not be a result produced from bunglers. Few carriage builders carry on many branches of work on their own premises; none carry on all the branches, for it would not be worth their while on a small scale, and on a large scale it would be too enormous an undertaking. Some carriage builders there are who get all their work done by a class of small tradesmen called piece-masters, who work for a very small profit, getting up a single carriage at a time and selling it the moment it is made. In this case the ostensible carriage builder is merely a retail shopkeeper. Many of these carriages are made by apprentices and inferior workmen. Others there are who get their bodies and carriages made by piece-masters, and do their own painting and finishing. Some of these piece-makers turn out very good work; but generally, being men without capital, they cannot afford to keep a stock of dry material, and their work, even if good, will not stand. A considerable capital is essential to the production of good carriages: unless the artist possesses a control over his tradesmen, he cannot be sure of the quality of his work, and no control is so effectual as that of paying them ready money. Some carriage builders pass half their lives nominally as masters, but virtually only the foremen of their tradesmen, who find capital and supply them with goods at their own price. From this state of thraldom it is difficult for a man to free himself.

The value of all wrought material is of course dependent on the amount of human labour necessary to produce it. What a carriage builder calls material, is all that which he pays money for, and brings on his premises to work up in

his combinations. Scarcely any of it comes to him in a crude state; but whether it comes to him in the shape of a set of axles whose principal value is in the labour bestowed, or in sponge or rotten stone which are merely gathered from the stores of Nature, he regards it all as simple "material." Expensive as are the materials of carriages, so understood, they are not equal in amount to the wages of labour paid weekly in large carriage factories. Skilful workmen who work by correct eye and sound judgment are never too numerous, and they must be highly paid.

The workmen usually employed in the best factories are,

Body Makers, Carriage Makers, Carvers, Smiths, Trimmers, Painters, Brace and Harness Makers, Sawyers, Labourers.

Designers, Draughtsmen, and Herald Painters, of course come under the category of artists.

It has been before shown that the success of a carriage builder depends much on his taste in design, and judgment in execution. One, if not more of the partners in a firm, is therefore usually a designer.

The workmen usually employed by carriage builders out of their own premises, through the agency of other tradesmen, are,

Axle-tree Makers, Spring Makers, Wheelwrights, Lamp Makers, Trunk Makers, Blind Makers, Joiners, Turners, Lace Makers, Curriers, Japanners, Ivory Workers, Platers, Chasers, Embroiderers. Many more workmen are indirectly employed, such as cloth workers, silk weavers, glass makers; screw, nail, and lock makers, and metal workers

generally; carpet weavers and floor cloth makers, waterproof cloth makers, cotton workers, tanners, morocco dressers, hemp and flax workers, glue makers, colour and varnish makers, and others, who do not work exclusively for carriage builders.

Body-makers are very skilful joiners, using several kinds of wood, and working up many forms in which there is not a single plane surface. The essence of their art is to show perfect forms in the lines of their work without breaks or inequalities; and many of these lines are double convex or double concave. The principles of this work are essentially geometrical, and the more difficult forms of geometry are the most common. The workman must know how to draw well, or he cannot work well, and to be enabled to do both, he must possess correctness of eye and skill of hand. He has to make correct joints at every variety of angle, and has to resort to every mode of uniting his materials. The tenon and mortice, the scarf, the lap, the groove, the glue joint, the bolt, the screw, and the nail, are all employed. The materials he uses are ash, elm, birch, mahogany, pine, and deal; and he must also possess some skill as a metal-worker efficiently to fit the various plates of brass and iron which enter into the composition of his work. It is not absolutely necessary that he should possess taste; but fidelity in copying he cannot do without. And he must possess a capital in tools, varying from thirty to forty pounds. As such men are not numerous, they command high wages. They do not usually work by the day, like many other workmen, but by the piece. Two

men working together have been known to earn in the space of a week twenty pounds, but it was by great exertion, working early and late, sixteen hours per day, and taking their meals on their work-benches. When in full work, very quick workmen will earn five pounds per week; but as they seldom have full work the year through, they do not average more than four. Ordinary workmen do not earn more than three pounds per week, and on the average less than that.

Carriage makers are more akin to millwrights in the work they perform, though much less skill is required in geometrical knowledge. Their work is heavy, and requires great truth in all the framings; but the lines are on a larger scale than those of the body-maker, and therefore slight inaccuracies are not so perceptible. They have also few double convex or double concave lines, and more plane surfaces. The materials they use are ash and elm, much of them in combination with iron-work supplied by the smith. Neatness, but not extreme delicacy of work, is required in the carriage maker: he requires fewer tools than the body-maker, and his earnings, while employed, are, by piece-work, from three pounds to two pounds per week, according as he may happen to be a good or indifferent workman.

Carvers, are the workmen who execute the ornamental wood-work of carriages. Some of them are artists, furnishing designs as well as executing them, and of course are in such cases highly paid. Others are merely the executors of the designs of others. There are two classes of carving used in carriages: the simplest consists of the

beads and mouldings on the framework of the body, and also on the carriage timbers; the other consists of leaf-work and tracery, according to fancy, and is used to ornament blocks of various kinds, as well as the hind standards, and also on the timber ends. The designs for these purposes are similar to the scrolls and volutes used in architecture. The earnings of carvers are from thirty shillings up to four and five pounds per week, according to their skill; but, like many other workmen, they are unemployed several months in the year.

Coach-smiths are the most skilful of all iron-workers. They have to work large and heavy bars of iron into forms containing several unequal curves, the thickness of the metal also being unequal. It is a work guided by the eye more than by measurement, and there are few straight lines to work from. The coach-smith must be able to draw, or at least to criticise forms accurately, or he will not prove a skilful workman. He must possess considerable personal strength, and capacity to bear the heat to which he is exposed; he must be a good judge of the metal he uses, and so contrive his work that it may appear light, while capable of efficiently resisting the strain upon it; and it must moreover be truly wrought, being all intended to fix to wood-work previously prepared. Men possessing so many different qualities are not numerous, and therefore are highly paid. Coach-smiths are divided into three classes, — fire-men, hammer-men, and vice-men. The fire-men are the class just described. The hammer-men aid them in their work, with the sledge hammer, when heavy blows are required to reduce the

metal in size or form; they also blow the bellows and make up the fire,—in short, perform the office of labourers. And hence arises much injustice. If the hammer-man happens to be a skilful man, he frequently applies himself to work in the fire-man's absence. The latter, as soon as he discovers it, grows jealous, quarrels with, and discharges his hammer-man. Thus, the hammer-men live in a position from which they are forbidden to emerge, even if they possess the necessary skill.—The business of the vice-man is to file and smooth the work from the rough marks of the hammer, to fit joints, and finish screw-bolts and nuts. Neatness and skill are required in his work, but not the precision of eye required in the fire-man. Fire-men mostly work by the piece, and earn from two to three and four pounds per week, according to the class of work: the hammer-men earn from twenty-five to thirty shillings, the vice-men, from thirty shillings to two pounds.

Smiths have usually been esteemed a very drunken race; but this estimate of them must be taken with a reservation. They were formerly much more so than at present, like other mechanics; but, like them, they are fast improving. Men who work hard in a heated atmosphere have a tendency to drink more than those who do not; and with the imperfect arrangements which are so common in smiths' shops, it is not surprising that some of them should become confirmed drunkards. Contrivances will in time be resorted to, to enable the workman to avoid the heat while working; and probably tilt-hammers will be so contrived that there will be no necessity to breed

up hammer-men to a trade in which they can make no progress.

Trimmers, are to carriages what upholsterers are to houses, in what regards the interior lining. They use similar materials; as, cloth, silk, morocco, canvass, webbing, curled hair, wool, flocks, &c. But, in addition to this, they have to use the more stubborn material of leather, in various ways, as for the coverings of folding carriage heads, in what is called "open work." Herein much judgment is required.—The work of some trimmers is entirely confined to leather work, and their technical designation is "budget trimmers." They sew on the leathers to the iron frames called dashing or splashing irons and wings,—cover poles and shafts with leather in the wearing parts,—cover the small cases called tool budgets, drag chains, safety chains, and ropes, and other similar work. In these employments, the men who cut out, require much judgment, and also some taste, in order not to waste valuable materials, and also to make their work firm, and at the same time neat and agreeable to the eye. The earnings of trimmers who are skilful cutters are from three to four guineas per week; those who are merely workmen earn from thirty shillings to fifty.

Painters are an important branch of the carriage trade, for on them the general good appearance of the carriage depends. The director or foreman must be an accurate judge of colours, as to their durability, and also as to the effect which varnish will have on them. He sometimes has to match a single panel which has been damaged, and it is a very nice operation to match a new colour to an old one, more

especially when the colours are conspicuous. The mechanical skill required in painting is not very great: that portion which consists in what is technically called "picking out," or painting fine lines of a distinct colour, on a ground-work, —as black on yellow,—requires the greatest skill. The wages of a foreman are from two to four guineas per week. The ordinary workmen earn from twenty-five to thirty-five shillings, according to their skill; and they are by no means too highly paid, considering the unhealthy nature of their employment, in heated apartments impregnated with mineral and other odours. Generally speaking, painters are more healthy of late years than they formerly were, and this must be attributed to their increasing habits of greater personal cleanliness.

Brace Makers and Harness Makers are generally ranked together, on account of the similarity of their work. The braces of a carriage serve to support the body on the springs, and also to confine its oscillations within certain limits. The braces are combinations of two or more straps of leather, increasing in number according to the strain they may be exposed to, and sewn together to form one substance. The cutter-out requires considerable judgment as to the quality of the leather, and also how to use economically the different parts of the hide which are fitted for different purposes, as they are not of a homogeneous texture or substance: he must also be able to calculate the requisite strength of material. The workmen who sew the materials together require little more skill than shuttle throwers: piercing the stitches with the awl is a mere matter of habit which almost any person can acquire. The wages of a

good cutter are from two to three guineas per week. The sewers earn from twenty-five to thirty shillings, according to their neatness of work. Their employment is unhealthy, as their work is always performed in a stooping posture, and working on black leather has a tendency to injure their eye-sight.

Sawyers do not require any great skill. Inferior carpenters and others commonly become sawyers. The work is rather laborious. Their earnings are thirty shillings per week. Very few carriage builders now use pit sawyers, as a single man at a bench with a small frame-saw is found far more efficient.

Labourers are a class of people employed by coachmakers under one designation, but varying much in their skill and ability. The commonest class are those who wash carriages and move them from place to place. The next class are those who are capable of polishing the metal-work and leather, and keeping the paint in order. The next and most efficient class are those who possess a general knowledge of the mechanical construction of carriages, and are capable of hanging and unhanging them, separating their various parts, replacing damaged bolts or iron-work, nailing on the wearing leathers, painting the iron-work, greasing, oiling, and adjusting the wheels. They must also be able to judge of the general condition of carriages, so as readily to detect defects which might render them unsafe in travelling. The weekly earnings of labourers are from twenty to thirty shillings, according to their skill.

Axle-tree Makers are divided into forgers or fire-men, turners, and vice-men. The work of the forgers requires

considerable skill and strength, to unite large masses of iron at a welding heat, and to reduce them to accurate forms: their work is akin to that of anchor-smiths. Axletree turners must be very skilful, accurate workmen, to fit the patent oil axles truly: for the common axles used with grease, inferior workmen will suffice. The vice-men also require much skill and practice in filing, to enable them to work true, which is absolutely necessary in axles. Were these men taught to work in wood first, as is the case with millwrights, skill would be more frequent amongst them than is the case at present. The forgers earn from three to four pounds per week; the turners, from two to three pounds; the vice-men, from thirty shillings to two pounds,—but the latter sum is not common.

Spring Makers require considerable skill, especially for the construction of circular or C springs with many plates. They work by the aid of a hammer-man, like other smiths, and have a vice-man to finish their work. The modes of working being exceedingly imperfect, their work is empirical, and thus some few by long practice acquire skill in tempering the steel, which others do not attain, simply from want of instruction. Spring-makers earn from two to four, and occasionally six pounds per week; the vice-men and hammer-men, the same as in other cases.

Wheelwrights must be skilful workmen; for their work is so severely tested, that if not true and sound, it must fail, and moreover, the accuracy of it depends more on truth of eye and skill of hand, than on any marks, guides, or rules. First-rate wheelwrights earn from two to three pounds per week; but their work is very laborious

Tire-smiths are a branch of the wheeling trade; an unskilful tire-smith does much damage in a short space of time, and skilful ones are not abundant; their earnings are from three to five pounds per week, and occasionally more than that.

Lamp Makers have no hard work to perform. Their work consists in cutting out thin metal and soldering it together. It requires neatness, but no considerable amount of skill or exactness. The effluvia of a lamp-maker's shop is unpleasant, but not positively unwholesome; yet the sitting posture in which they perform their work is not favourable to health. Their earnings are from twenty-five to thirty shillings a week.

Blind Makers, Trunk Makers, and Joiners are reciprocal trades. The amount of skill required by the workmen is not very considerable. Their earnings are about thirty shillings a week, and their work is very light. The joiners make wainscot cases, seat boxes, &c.

Turners are employed by carriage builders to turn splintre bars, splintres, drag staves, raisers, and similar things. Their earnings are thirty shillings a week.

Lace Making formerly constituted an important branch of carriage building, as skilled workmen were few, and they commanded very high prices for their labour. But the art of lace-making is no longer a sealed book; the workmen have increased in number, and although a first-rate workman can earn three pounds per week, still, as he does not on the average work more than three or four months in the year, the total amount is very trifling. Formerly lace-making was confined to London; but since the increase of

carriages it has become more of a manufacture, and is made wholesale at Manchester and other manufacturing towns. The London carriage lace makers are, like most weavers, a miserably poor and squalid race; as is the case with all trades which are wearing out, or where the mode of operation is changing.

Curriers are the workmen who dress the leather which has been converted from the raw state by the tanner. Considerable skill is required in the operation of levelling the hide by a peculiar process called shaving, and the work is laborious. When in work, the men can earn from two to three pounds per week at piece work; but their numbers keep many of them constantly out of employment. Currying has generally been considered a profitable business for the masters, and the reason has been, that considerable capital is required in it, combined with judgment in buying material. Tanners do not give credit, and the currier has to lay in his stock of hides at particular seasons. Without great skill to judge of the quality of a very deceptive material, he may easily be ruined. It is a healthy trade for the workmen.

Japanners, in the leather trade, are those who prepare the glazed and enamelled waterproof leather used for carriages. Those who carry on the business are generally employed by the currier who finds the leather. Considerable knowledge of materials is required, as it is essentially a chemical art, and the material on which the japan is spread is very liable to injury. The workmen earn the same as other painters, and the employment is far from healthy, on account of the great heat necessary.

Ivory Workers are divided into turners and carvers. The former earn from thirty to forty shillings per week—the latter considerably more, as they require more skill. The turners prepare rollers and buttons for glasses and blinds; the carvers cut out ornamental crests for seat-cloths.

Platers prepare the ornamental metal-work, such as door-handles, and the beading which covers joints, as well as buckles and all the metal-work used in harness. The earnings of the workmen are about thirty shillings per week.

Chasers emboss the crests, arms, &c. on the door-handles, heads, and axle-tree caps, as well as other ornamental work. The ordinary workmen earn two guineas per week; but designers are paid much higher in proportion to their skill.

Embroiderers prepare crests and coats of arms to ornament the seat-cloths. Their work being principally fancy, no fixed price is attached to it.

Notwithstanding the apparently high wages earned by the greater part of the workmen employed by carriage builders, but few of them, and those only amongst the most skilful, enjoy constant work. High wages have produced the common effect of increasing the numbers of the workmen beyond what are necessary for the demand. The consequence has been, that inferior workmen have been found willing, occasionally, to work at a lower rate of wages, for small masters, who work on speculation, and get carriages up cheaply with inferior materials, for the

chance of a ready-money sale. In order as much as possible to counteract this, and prevent the low rate of wages from becoming general, many of the workmen have joined together in a Trade's Union, binding themselves not to work for low prices. The consequence is, that there are two classes of men,—those who belong to the Union, and those who do not: but this makes no actual alteration in their relative condition as to their earnings. The most skilful men belong to the Union rather for the sake of quietude and remaining unmolested, than from any value they attach to it, because they know that with or without the Union their skill can always command constant employment at the highest rate of wages. The other Unionists share amongst them just as much employment as there may happen to exist; and they would do just as much without the Union, inasmuch as it neither increases nor diminishes the total amount. If they be good workmen, they get employment; and if they be bad ones, the Unions cannot procure it for them. And those who do not belong to the Union, are in the same precise condition: those who employ them select the most skilful, and leave the others without work, unless under the pressure of necessity. The only advantage the Unions can appear to hold out, is the prevention of interlopers from working at the trade, without serving a regular apprenticeship to it; but as these interlopers can work in other shops, not belonging to the Unions, they are not in reality kept out, but do the Unionists greater mischief by working at a lower rate of wages. It has been supposed by many, that great mischief may result to the

public from the general customs of Trade Unions; but the supposition is unfounded. On the contrary, experience and discussion will most probably convince the Unionists that combination cannot raise their rate of wages; and the elements of dissolution are moreover constantly at work amongst them. They are not an equal body, but one composed of classes taking rank one after another. In the carriage manufacture it is peculiarly so. The body-makers are the first on the list; then follow the carriage makers; then the trimmers; then the smiths; then the spring-makers; then the wheel-wrights, painters, platers, brace-makers, and so on. The body-makers are the wealthiest of all, and compose amongst themselves a species of aristocracy, to which the other workmen look up with feelings, half of respect, and half of jealousy. They feel their importance, and treat the others with various consideration, according to their station. Carriage makers are entitled to a species of condescending familiarity; trimmers are considered too good to be despised; a foreman of painters they may treat with respect, but working painters can at most be favoured with a nod. A smith is considered quite unendurable, — a regular drunken, beer-drinking "Ironsides;" and a plater is contemptuously denominated "bead-sticker." A wheelwright is held to be a kind of rough wood-chopper; and a brace-maker, a mere vulgar "snob." The other classes partake of the same feelings of caste in their various proportions. A body-maker is considered a "good catch" as a husband for the daughter of an ordinary mechanic; and the carriage maker excites much anxious feeling on the part of mothers, who con-

sider marrying to a carriage maker as important a matter as vulgar-minded mothers in the classes just above them consider "marrying to a carriage."

All these things of course create much jealousy and bickering. The progress of democracy is not likely to be advanced by the agency of Trades' Unions formed of such ingredients.

CHAPTER XIII.

Steam Locomotion.—Canals — Railroads.—Engines.—Boilers.—High and Low Pressure.—Tubular Boilers.—Durability of Steam Engines.—Difficulties of Steam Vehicles on Common Roads.—Mr. Hancock's Carriages.—Speculators in Steam Carriages.—Defects of Steam as applied to Pleasure Carriages.—Steam compared with Horses.—Steam adapted to Railroads, but not to Common Roads.—Probable Increase of Pleasure Carriages by means of Railroads.

From the time that Mr. Watt first brought to perfection continuous circular motion by the agency of steam,—from the time that the first steam fly-wheel was seen to revolve,—it became an easy thing to imagine, that if a steam-engine were provided with four fly-wheels, supporting it on a horizontal surface, it might be made locomotive. The idea doubtless occurred to many; but necessity alone could reduce the idea to general practice. The increase of human wants gave the first employment to steam as a mill-grinder, machine-mover, water-pumper, and coal-lifter; and its first rude attempts at locomotion were as a coal-porter, to drag, in waggons, the coals it had raised from the pits, to the place where they were to be embarked in ships or barges. At the Northern collieries, the first locomotive engines were used on railroads. But this was only for short distances. As population thickened, and commerce and manufactures increased, rapidity of inland transport became an important object.

Canals were found available to facilitate the transport of heavy goods too inconvenient for land carriage; but they were impracticable as a means of rapid transport, and liable to interruption in winter. Land carriage on ordinary roads by means of horses was too expensive, and railroads had only been applied for short distances for particular, and not general purposes. At length a railroad was planned between Manchester and Liverpool, and all difficulties being vanquished, locomotion by means of steam was found profitably available, at double the speed which could be obtained by draught horses. But the original expense of constructing the road was so great, that many speculators, with added energy, applied themselves to the task of making steam locomotion available on common roads.*

Wheel carriages drawn by animal power are moved by the *external* leverage of the animal's limbs put in action by expensive muscular force combined with gravity. Steam carriages, on the contrary, are moved by an *internal* leverage acting on the wheels by the elastic force of steam, either by a crank on the axle, as a man turns a grindstone, or by some other contrivance producing the same effect. Therefore, when the wheels turn on their axes, it is necessary that the peripheries should hold firmly to the ground, and not slide on it; or the forward move-

* The Chat Moss was a most formidable and expensive enemy to the Manchester Railroad. The history of the struggles between the skill, intelligence, and perseverance of the elder Mr Stevenson, and his capricious illusory antagonist, the Moss, is very remarkable. As this road now exists, it is in reality a floating causeway, as carefully ballasted as a ship, to securet he equilibrium.

ment will not be obtained, but, instead of it, the wheels will grind a hole, and gradually sink down. Therefore, in order to obtain the forward motion, a certain weight must be placed on the wheels, to increase the friction and keep them from slipping. But this weight will be unavailing, unless the road on which the wheels rest be sufficiently hard, firm, and unyielding in all parts, to prevent the wheels from sinking below its surface. If it be soft, it will not afford a sufficient fulcrum for the wheels to act on.

That part of an engine which generates the elastic force of steam is called the boiler. The larger the boiler, *i. e.* the greater the surface of water exposed to the boiling action of heat, the greater will be the quantity of steam generated. And in proportion as the intensity of heat is increased, so is the power of the steam; but in that case the boiler must be made proportionately stronger. Boilers which are calculated to bear a pressure of steam equal to fifteen pounds to the square inch are called "low-pressure;" those which are intended to bear a greater pressure to the inch are called "high-pressure." It is therefore evident that the high-pressure boilers with their charge of water may be much lighter, and occupy much less space than the low-pressure ones. In stationary engines, where neither space nor weight are of consequence, low-pressure boilers are most commonly used; but in a locomotive machine, it is important to diminish as much as possible both the weight and bulk, and therefore high-pressure boilers are preferred. But boilers may chance occasionally to explode from unforeseen causes, as guns go off and

houses are occasionally burned down, by accident. In case of an accident, which is more likely to happen with a high-pressure than with a low-pressure boiler, the danger is much greater with the high-pressure than with the low-pressure, because the elastic force of the steam is greater. In a steam-coach, it would almost infallibly be fatal to the life of the engineer, if not of the passengers. To obviate these effects a new kind of boiler has been adopted. Instead of holding the water in one dense body, it is made to circulate through a number of small tubes, round which the heat of the fuel plays. These tubes are all connected together, and contained within an iron casing. Some one of these tubes may have a flaw which causes it to burst; but the explosion is so trifling, that no danger can be apprehended. A very small portion of the total force is expended in the explosion, and the water immediately leaking out, the fire is extinguished.

But though the danger is removed, these boilers are found to give little steam power in proportion to their weight; and the vehicles which are constructed with them for the most part are inefficient, except on very hard firm roads. A loose surface stops them, and a hill is with difficulty surmounted. But this is not all. The durability of a steam-engine depends very much on its being kept at one rate of speed, and that the elastic force put in operation be constantly the same. On roads which vary in their texture and in their level this is impossible; up hill the power of the engine must be exerted to the utmost,—consequently the engine must be sufficiently strong for the hardest work, and the extra weight and strength will

prove an incumbrance on level ground. Rail-roads are of even surface, but Macadimised roads are uneven,—consequently, delicate machinery on the latter must suffer much destructive wear. It is only by making the road very firm and even, or by the substitution of very efficient springs, that this destructive wear can be alleviated. Very heavy carriages, such as steam carriages must necessarily be, will beat themselves to pieces over rough roads unless their rate of movement be very slow. The size of the obstacle, or the depth of the inequality, is multiplied in compound proportion by the increased rate of motion. And where efficient springs are used between the moving wheels and the machinery, it is evident that there will be a greater tendency in the wheels to slip round without moving the vehicle. Now, in locomotion, one chief advantage which steam has over animals is not merely its power of working unceasingly without tiring, but also the capability of exerting any needful increase of power to increase the rapidity of movement. As regards a steam-coach carrying passengers on its own wheels, the inequality of a road is a sufficient difficulty; and for a steam-drag drawing passengers in separate vehicles, a common unfirm road with an undulating surface would considerably increase the difficulty in the present condition of locomotive machinery. The natural powers of an animal's limbs are adapted to surmount natural surfaces, though rough or difficult; but the artificial limbs of steam are only adapted to artificial causeways of an equal degree of excellence.

But though steam vehicles in their present condition, as regards the roads they travel on, are not adapted to ge-

neral use, it is no argument that skill and dexterity cannot eventually bring them to bear. They have improved much since the first attempts were made, and the numerous speculators at times engaged on them, are continually adding to the knowledge of what will not do by their failures, and something also to the knowledge of what will do, by their partial success. Gradually, the stock of knowledge contributed in small portions by different persons will be combined to produce a more efficient result. Wheels will be better constructed to prevent them from sinking into the road, and springs will be contrived to produce the necessary ease to the machinery without impeding the movement. One of the most patient, skilful, and persevering, amongst steam carriage speculators, is Mr. Walter Hancock of Stratford, and the compound progression with which he has produced several carriages is a remarkable proof of what has just been advanced. In the year 1826 he took out a patent for a boiler, not constructed of tubes, but in flat partitions forming compartments. It was not until the beginning of 1831 that the first carriage, called the Infant, constructed with this boiler, was enabled to run. In 1832 a second carriage, called the Enterprise, was commenced, and in April 1833 it was running for hire. The third carriage, the Autopsy, was commenced in 1833, and by October of the same year it was on the road. The fourth carriage, the Era, was commenced in 1834, and by August of the same year it was completed. In the same year also a steam-drag was completed and shipped for Vienna. In all these carriages there has been a gradual improvement of construction, as

well as rapidity of execution, which will not cease to make progress till perfection be attained, or till perfection shall have ceased to be an object of desire, by the attention of the inventors being turned to objects of greater profit and utility.

It is not generally known that the idea of a steam-coach occurred to Mr. Watt, and is even proposed in one of his patents, but was never acted on. The commencement of actual construction for common roads was about the year 1825. It may seem strange that a considerable number of persons should have been separately engaged for ten years on the same object without producing a perfect result; but Mr. Watt himself was engaged twenty years with his inventions ere he brought them to perfection. Many years also elapsed between the first attempts at steam-boat locomotion, and its regular establishment as a matter of business. The difficulties to overcome in rowing vessels by means of circular paddle-wheels are assuredly less than those of propelling coaches over rough roads; but steam-rowing had its difficulties to contend with nevertheless. There was a sufficient number of people who knew how to build ships, and also a sufficient number who knew how to build steam-engines; but those who had to combine them must necessarily serve an apprenticeship to a new art, ere they could harmonise differing materials, and ascertain the proportions and true forms of the various parts. And this is the case with steam-coaches. A combination of the practical knowledge of the carriage builder and the engineer was necessary, to enable an inventor to put his plans in execution; but mechanical men in regular

business rarely embark in speculations. The speculators, for the most part, were neither carriage builders nor engineers: they possessed general knowledge, but very little knowledge of details; they knew nothing of proportion, and as they went on,—mostly in pecuniary difficulties,—they were obliged to acquire their knowledge in the school of costly experiment. And even engineers could not avail themselves of their previously gathered knowledge, but were constrained to learn afresh. The proportions of parts, adapted to stationary engines, are not fitted to encounter the uncertain concussion and momentum of rough roads. Strength must be provided to resist the greatest amount of concussion, and it is at the same time necessary that all possible lightness should be preserved. To accomplish these two opposite objects, the greatest nicety of calculation is required,—and that calculation can only be verified by repeated experiment. All this must be at the cost of the needy speculator; the public at large does not interest itself, till doubts have vanished, and certainty has taken their place,—unless the speculator be a good advocate, and can persuade them to believe in a certainty he himself believes, but has not verified. In such cases the knavish speculator who aims at people's pockets, and not at mechanical success, has a better chance than the honest one.

But even in the present condition of steam-coaches, enough has been done to excite the prejudices of many carriage builders, who fear lest their trade should be encroached on. They fear it may be possible for steam to supersede horses in pleasure carriages. To analyse this, we must first define what is meant by pleasure carriages. All carriages which

carry human beings may be called pleasure carriages, inasmuch as they are constructed to avoid the pain of walking; but the best definition of a pleasure carriage is, one not used for the purposes of business, or mere conveyance between near or distant places,—but for the purpose of pleasant exercise in the open air, or to facilitate the intercourse of social life, not as a matter of necessity, but of enjoyment. For pleasure carriages as thus defined, it is not likely that steam will be considered available. The reasons are sundry. In the first place, steam is a mere labourer—a drudge who performs his work without speech or sign, with dogged perseverance but without emotion. By dint of the garb in which he is clad, the machine which serves him for a body, he sometimes puts on the appearance of a live thing, shaking his polished metal clothing like an armoured knight but this is only when he is stationary. His travelling garb is rough and rude, his breath is sulphureous, his voice is hissing, his joints creak, the anointing of his limbs gives forth an unpleasing gaseous odour, he carries with him a kitchen and a fuel chamber, and his whole appearance is black and unsightly He may be personified when speaking *of* him; but no one pats his neck or speaks *to* him in a voice of encouragement It is not so with a horse or horses. They are beautiful and intelligent animals, powerful yet docile; creatures that respond to kindness, and shrink from cruelty and injustice. The driver and owner can love them or feel proud of them; they step with grace, and can vary their form and movements in a thousand ways. They are creatures of individual impulses; and although injudicious treatment occa-

sionally reduces them to blindness by artificial means,—though injudicious custom chooses to govern them by the sense of feeling rather than by the inflection of the voice modulated to their ear, still there is felt towards them a species of companionship. The man who rides a horse, feels a pleasure when the creature responds willingly to his purposes, and when he responds unwillingly, he feels a pride in the exercise of his power to compel him to obedience. Even when a horse is vicious, there is a pleasurable excitement in riding him. The rider's nerves are strung, his senses are quickened; eye, hand, and ear are alike on the alert, the blood rushes through the veins, and every faculty is aroused. There is a feeling of proud consciousness that his individual skill and dexterity can render his life as secure in peril as other men's are under ordinary circumstances. Many men there are who prefer a horse to a certain extent dangerous.

> "Oh! the blood more stirs
> To rouse a lion than to start a hare."

Most men like a horse with vivacity, and few choose one which is merely adapted to work,—at least for riding. And thus it is with driving to a certain extent,—that is to say, for pleasure purposes. The carriage is built to harmonise with the horses, and the horses are selected to set off the carriage well. The carriage and horses form a combination, and if they possess not harmonising points, they are unsightly. A cart horse in an elegant carriage is as much an anomaly as a blood-horse in a heavy cart.

But there are persons who merely need a carriage for the purpose of moving in the open air without personal

trouble, and to whom a machine would be preferable if it afforded them the same facilities, together with a diminution of the inconveniences. In its present state, steam is not capable of supplying this purpose. The boiler and appurtenances are necessarily of great weight, and the smaller they are made, the more proportionately heavy do they become as regards the work they are capable of performing. Fire, even of coke or charcoal—steam—the empyreumatic odour arising from heated oil, together with hissing noises, are nuisances of great amount. A steam gig or chariot would undoubtedly be a great acquisition for night work, saving horses and servants alike from illness and annoyance. It is a painful sensation to be at the opera and be conscious that the horses and servants are suffering pain, and perhaps imbibing the seeds of disease, exposed to rain, snow, or frost; but as these are only casualties, they will be endured, rather than the certain annoyances from steam in its present state will be submitted to. For short trips by sea, steam is endured, because it is certain in its time, and against its inconveniences are to be set the fearful inflictions of protracted periods of sea sickness in sailing vessels; but if it were a question of a permanent dwelling on the sea, most persons would prefer a sailing vessel to a steamer.

And our present state of knowledge affords little hope that the inconveniences of steam can be efficiently removed. The old name for "steam-engine" was "fire-engine." The truest definition would probably be to designate it a "heat-engine." The heat is the real mover; the water is but the vehicle in which to apply the heat, just as the

water in a Bramah's press-pump is but the vehicle to concentrate the force of the human arm applied through the lever. Water absorbs heat as spongy wood absorbs water, and its bulk being increased by it, it acts like a wedge against whatever restrains it. Attempts have been made to use heat through other agencies,—as the various gases, and atmospheric air; but they have not yet been found practicable. Could the gases be used, the weight of the charged machine would be lessened by the substitution of a light medium for a heavy one; but the weight of the machine itself would remain the same, as the same power of resistance would be necessary. It is possible that in time the ill-odoured gases evolved from heated oil may be neutralised by mixing them with other gases, and the chief mover, fire, made exact and unerring in its application, without smoke or vapour: but this is to calculate not on what is, but on what may be.

It seems not likely that steam can be applied to pleasure carriages; but improvements will most probably go on in the construction of steam carriages, till they be perfectly available for common roads as vehicles of locomotion,—as a means of travelling more economically than with horses from one place to another. But to realise a profit from them, they must carry many passengers: they will do for public, but not for private vehicles. One advantage they will possess which common vehicles have not: in cold weather they may be warmed by the steam-pipes with the same facility as a house, and in hot weather they may be ventilated by fanners worked by the machinery.

But, when all this has been done, it will not be worth

while to work steam-coaches on common roads, for a simple reason. Wherever there may exist traffic enough to warrant the use of steam-coaches, it will be worth while to lay down rail-ways. Those who are strong advocates for steam-coaches on common roads usually assume that railroads are enormously expensive in their construction, and that common roads cost nothing, or but little. But this is an unwarranted assumption. The expenses of rail-roads are heavy in the outset, by reason of the necessary embankments, deep cuts and tunnelling, together with the purchase of land, and the erection of bridges or tunnels to keep up the communication on intersecting lines of road. But is not this also the case with common roads on new lines? The true question at issue is, whether, after the level has been produced, it be more expensive to lay a rail-road or a Macadamised road capable of bearing a specific weight. In some districts the expense of Macadamising with granite is enormous, on account of carriage; and for steam-coaches, the roads are required to be of the very best kind, or they will not bear the weight. Allowing that the rail-roads be most costly at first laying down, there can be no comparison as a question of repairs. All that can want renewal are the iron rails and fastenings; and the steamers on the rail-road can carry their own materials, which the steamers on common roads cannot so conveniently do, the bulk being so enormous. And the amount of load which the same amount of power will draw on the rail-road, owing to the lessening of friction and concussion, is very considerably increased. And lastly, the difference of speed is an unanswerable reason for giving a preference to the rail-road. Fifteen miles per hour is probably the outside per-

formance which common road steamers can attain without shaking themselves to pieces; while on rail-roads twenty-five miles can without difficulty be attained. Where very great speed is not required,—as for short distances and frequent stoppages, such as the common omnibuses are used for,—it may eventually be worth while to employ steamers on common roads when they are sufficiently improved. The momentum acquired by great speed, which is found so advantageous on rail roads, would prove a serious difficulty in the case of frequent stoppages.

The constructors of pleasure carriages have not only nothing to fear from the encroachments of steam, but, on the contrary, they may regard it in the light of an ally. Since the invention of steam-boats, the facility of exporting carriages to Ireland and the Continent, without the necessity of expensive packing, and without the uncertainty of arrival, has led to a greatly increased demand. In spite of the unwise exclusion contemplated by the custom-house laws of France, English carriages are now commonly seen in Paris and other parts, and they are universally preferred. On an infinitely greater scale will carriage-keeping be promoted by the introduction of rail-roads. Time was, that travelling coaches were something like baggage waggons, and travelled as slowly. People wanted to travel faster, and their baggage was sent by the waggon, as heavily-laden vehicles would not bear rapid motion. But the vehicles were improved, the baggage was lightened, and goods and passengers again travelled together. But the vehicles were wanted for other purposes than mere travelling; they were needed as pleasure carriages in towns. Invention was set to work, and the same vehicle was made

to show like a town coach one day, and like a travelling coach the next. But such vehicles are necessarily imperfect. The springs which are adapted to carry a light weight easily are not adapted to carry a heavy weight, and *vice versâ*: and a carriage must necessarily lose much of its beauty when used for travelling. These disadvantages have prevented many persons from keeping carriages, and have obliged some few to keep two carriages. But another motive has perhaps been still more forcible. In travelling with a carriage rapidly, it is necessary to go with post-horses, or to travel by very easy stages, with a single pair. Few persons like to travel slowly, and fewer still, to leave their horses behind them and be deprived of their use; and as the habits of those who keep carriages are mostly migratory at particular periods of the year, they would rather cease to keep horses and carriages than be confined to one spot. The desirable thing is to have one pleasure carriage perfect in all its parts, and to be able to convey it, servants, horses, baggage and all, at a rapid pace, from one point to another, without injury to carriage or horses: to have the perfect use of it at any required spot, with as much facility as though the owner had not left his home.

Steam locomotion on rail-roads will accomplish all this. The driver or the owner may drive the vehicle, with the family, servants, baggage and all appurtenances, on to a platform securely railed round, and steam will do its office in conveying them to their destination, without concussion, and without damage to the vehicle. When this shall come to pass, pleasure carriages will increase in number manifold.

CHAPTER XIV.

Taste.—Definition of Taste.—True and False Taste.—Originality and Imitation.—Form, Colour, and Proportion.—Defective Proportions of Carriages.—Natural Forms.—Ornaments contrived to cover defects.—Colours.—Heraldic Bearings.—Disposition of Ornaments.—Trimming.

THERE is a notion prevalent amongst uninstructed people that the quality called Taste is a peculiar "gift," which an individual is endowed with at birth, and which cannot be acquired by any amount of application. Some portion of this belief is founded on reason, inasmuch as the physical faculties of some individuals at their birth are more perfect than those of others. Some are born with weak, and others with strong eyes: and the same difference may exist in the perceptive faculties generally, on which faculties the quality of Taste must depend. But even as weak eyes may be strengthened by judicious treatment, and strong eyes may be weakened by injudicious treatment, so inferior perceptive faculties may be improved by cultivation, and those which might have been first-rate may disappear by neglect. Nearly all people have the germs of Taste, but in some nations those germs are developed more than in others. Even in those nations where the germs of Taste are developed in but few individuals,—where the mass of the community cannot

discover beauty for themselves, they are yet susceptible of its influence when it is placed before them by others. If it were not so, the expression "a person of good Taste" would not be used, as it so commonly is, as a mark of approbation. The phrases "a person of Taste," and "a person of Genius," in common language mean two different things; but they are in reality merely modifications of the same thing. Perceptive faculties of a high kind, without much cultivation, give a critical power to examine the productions of Art generally; but when highly cultivated, they give the power of creating works of Art of the highest kind,—and this faculty is by common consent called Genius.

Taste may be considered as another word for Truth or Proportion, both morally and physically. Thus, the utterance of a falsehood is bad moral Taste; it is a violence offered to Nature. In works of imagination, such as novels, those which offend a correct taste will be found to violate truth, probability, or proportion; and even when they are copied from Nature, it will be found a vitiated and distorted nature, forcibly perverted from the true type. Much false taste exists in the community, and always has existed; but the total amount is continually lessening. The reason of the false taste is, the imitative nature of man, which in an uncultivated state follows without examining. But even as it is the nature of water to attain a state of rest after violent oscillations, so it is the tendency of truth and proportion to grow out of the chaos either of thought or matter. When an individual by the force of his Genius or cultivated Taste sets

a true type in any work of art, the public soon begin to appreciate it, to take pattern by it, to imitate it,—and though many imitate badly, still there is a marked general improvement. Excellence cannot be attained by imitation; the principles of an art are the most important part of it, and when they are once thoroughly mastered by long-continued application, the details will be filled in with comparative ease. It is a far more tedious operation to imitate than to originate; and imitations, though they may be excellent as imitations, can never have the value of originals: they lack the intellect, the spirit, which Genius alone can bestow. Imitations of works of art are like the mimicries of the manners of living beings: they are caricatures rather than likenesses; being based on no rules, they bring the important parts into stronger relief than the main portions; they lay stress on the ornaments, and forget the lines of proportion; they overload the capital, and entirely neglect the base.

Carriages, as constructed for the purposes of pleasure, are works of art, in which Taste may be widely developed in Form, Colour, and Proportion; but the former is of course subservient to the mechanical construction. The hitherto defective mechanism of carriages, in which "a large wheel is made to follow a small one," has to a great extent destroyed proportion, and given a general licence to all kinds of heterogeneous devices and barbarous ornaments, as if to overlay defects which there were no apparent means of obviating. Custom has reconciled the public to this discrepancy, which, were it now to appear for the first time, would excite universal distaste and ridicule. The lines

of a carriage are generally arranged with the purpose of composing an elegant side view. To use an Truism, the side of a carriage is its front. Viewed as a piece of architecture, it presents a central elevation, with a large wing and a small one,—or rather, with two unequal pediments. If viewed as a locomotive machine, the exaggerated mechanical defect of the fore wheel being the smallest, is at once perceived. The birds which cleave the air or float on the waves, and the fishes which swim beneath the waves, are all constructed by nature with the breast broad, and the tail tapering off. The swift-footed quadrupeds have a greater length of limb before than behind; and ships and boats intended for speed have their extreme breadth very far forward. But an ordinary four-wheeled carriage is constructed in direct opposition to the principles of locomotion exemplified in animals and ships.

In an ordinary coach, the side form of the body is composed of elliptic lines, from which the supporting iron brackets or loops are continued into reversed curves. This contrivance keeps the centre of gravity low. The four C springs, from which the body is suspended by leathern braces, are each—or ought to be—two-thirds of a circle, with a tangent to it to form a base or support. The perch beneath the body, which connects together the framework supporting the springs, is curved into a serpentine line, corresponding to the bottom of the body and the loops; and thus a generally agreeable form is preserved. But the double framework in front, and the unequal wheels, entirely discompose the effect; and as a whole, it is extremely disproportioned, and consequently unsightly.

The framework and wheels look a huge mass of timber and iron work, much too heavy for the light load which is suspended on it. The wheels appear to project far apart from it, for no apparent reason. To restore something like a proportion of form, the hinder part is filled in with what is called the hind standard,—a composition of carved curvilinear wood and iron work, supported on a pediment or cushion, resting on carved blocks, —and the fore part is filled in with a black mass, with elliptic outlines, called the Salisbury boat. This is supported on a pediment of carved wooden blocks, and is surmounted by a mass of coloured drapery and fringe, called a hammer-cloth. Altogether it is a barbaric mass, which is only redeemed from positive ugliness by the harmony of the various curves as a whole; and to produce this harmony there are yet no ascertained rules. Therefore it is that the builder who possesses taste produces combinations pleasing to the eye; and he who is without taste produces unsightly works, which he is necessarily obliged to sell at a low rate of profit, as mere articles of convenience, and not of refinement. And even as articles of convenience, they are imperfect, inasmuch as the harmony of form arises from the due proportion of parts to each other, and that very proportion produces a greater amount of convenience. The size and weight of a carriage ought to be proportioned to that of the horse or horses intended to draw it, as well as that of the person or persons intended to ride in it, and also the locality and season it is intended for; and the proportion of parts having been once accurately settled, the same rule of pro-

portion must be observed, whether on an increasing or diminishing scale.

After settling the preliminary of Form, the next consideration is that of Colour. Taste in the latter can do much towards amending the defects in the former, or at least can divert the attention of ordinary observers from dwelling on them. Certain colours produce their effect by contrast; as green and red, purple and yellow, orange and blue: others again produce their effect by harmony; as green and drab, or brown and amber: others again by gradation; as the differing shades of greens and browns, in almost endless variety. Colours are generally divided into two classes,—the warm, and the cold. Red and Yellow, and their various gradations, are warm colours; Green and Blue, and their various gradations, are cold colours. The intermingling of the opposite colours forms neutrals. In choosing the colour of a carriage, various considerations intervene:—whether it is to be used in summer or in winter, or in both seasons;—whether it is intended to look rich in the outset, without regard to wear; or whether the chief consideration be durability, and the next, appearance. The warm colours are of course the most appropriate for winter, and the cold ones for summer; but those which look the richest are not generally those which wear the best. As an exception to this, however, the yellows, which are both rich and showy, are amongst the most durable colours. For bright sunny days the straw or sulphur yellow is very brilliant and beautiful; but for the autumnal haze, the rich deep orange hue conveys the most

agreeable sensations. The greens used are of innumerable tints, commencing with the yellowish olive, and gradually darkening till they are barely distinguishable from black. Neither apple green, grass green, sea green, nor any green of a bluish tint, can be used in carriage painting with good effect as a ground colour; but in some species of light carriages a pleasing effect may be produced for summer by the imitation of the variegated grasses. The dark greens look the richest, but do not wear so well, the slightest specks being magnified by the dark surface. They look best in the winter time. But the olive greens are preferable for the summer, as they show the dust less and are amongst the most generally durable colours. The browns are scarcely less numerous than the greens, and even more durable; but the lighter shades of brown have rather an unpleasing effect, far too homely for varnish. Some of the darker browns become exceedingly rich with the admixture of a reddish tint, from the first tint tinge, up to the deep beautiful chocolate colour, the intermediate shades between which and a decided lake afford perhaps the very richest ground colours used in carriage painting. Blues were formerly principally used as a ground colour for bodies, to contrast with a red carriage and framework. Of late very dark blues have been used as a general ground colour and when new they are very rich, being a glazed or partially transparent colour, but they very soon become worn and faded, the least speck or dust disfiguring them. Blue is also a cold colour, and while it is unfitted for summer by reason of its easy soiling, it is

unpleasant in winter, owing to its want of warmth. Drabs are very rarely used for painting colours, though for some peculiar purposes they might be advantageously applied.

In addition to the ground colour, other colours are used to relieve it, the framework of the body being generally painted black; and in the case of a very dark colour being used for the ground, it becomes necessary to run a very fine line of a lighter shade, in order definitely to mark the inner edges of the framework. The same process is pursued with regard to the carriage and under framework, for the purpose of making it look lighter to the eye. Were the perch, beds, and wheels painted of one colour, they would look exceedingly heavy and clumsy: but the skilful management of the fine lines, or "picking out," as it is technically called, produces a pleasing optical illusion. The same effect is sought also in the carved work, which would look very bare were it not heightened and brought into relief by the judicious application of black and coloured lines. The heraldic bearings, such as arms and supporters, crests and ciphers, which serve as ornaments to fill up the broad spaces of the panels, were formerly painted in their proper heraldic colours. With some bright grounds, such as yellow, the effect is occasionally good; but with others it destroys the general harmony of the carriage. On this account it has been customary of late years, when dark colours are used, such as greens and browns, to paint the heraldic devices in relief of the same colours.

Proportion in carriages applies both to Form and Colour. As regards form it regulates the sizes of the various parts

so that the whole may harmonise, and dictates the adoption of contrivances for lessening the apparent size of those parts which would otherwise be unseemly. Thus the total height which is necessary in the body for the comfort of the passengers is too great for the length which is convenient to assign it. Therefore the total height is reduced, and to give sufficient leg room a false bottom is affixed by means of convex rockers like a child's cradle, and which, being thrown back and painted black, cease to form a portion of the elevation; they are like a foundation out of sight, and thus the proportion of the front view is preserved. In painting the body of a coach or chariot, it is customary to confine the ground colour to the lower panels, and to paint the upper ones black, all except some stripes on the upper part of the doors. Now, inasmuch as colour in this case constitutes form by means of outline, and as that outline gives an irregular figure, it is a decidedly defective arrangement, making the upper part of the structure look heavier than the base. But the fact is, this defect has not been caused by intentional bad taste; it is a mere result of imitation, of following up old practices when the motive for them has ceased.—It was formerly the custom to cover the roofs and upper panels of all close carriages with greasy leather, in order to make them water tight, the edges of the leather being fastened down with rows of brass nails. This leather was black, and thus the eye became gradually reconciled to an unsightly object from a consideration of utility. After it was discovered that undressed leather could be strained on and painted, it was still considered necessary to paint it black, as the surface was not smooth

enough to show well with bright colours; and now that wooden panels are used to the upper as well as lower part, long custom has made the black colour of the upper part appear indispensable.

As by the present mode of constructing bodies, various joints are left exposed to view, where leather unites with wood, and where two varieties of wood unite in the same surface, it becomes necessary to resort to some mode of covering them. This is done by means of beading, or stripes of reeded metal with fastenings soldered to the inner side. In some cases this beading is blacked and scarcely shows; but in others it is of polished brass or plated, and thus marks portions of the outlines of the framework. This has an exceedingly bad effect, and gives the side lines a broken and unfinished appearance. Either the beads should not show at all, or the whole of the outline should be distinctly marked, as is the case in some few of the best finished carriages. The elegance of a carriage depends on the perfection of the outlines, and everything which tends to disturb those outlines should be avoided. Ornamental work conspicuously placed in injudicious positions ceases to be an ornament. Thus the loop heads are proper positions to place an ornamental boss, because they are the points where scrolls end and other lines commence, but the rings which sustain the check braces on the body should be kept out of sight, inasmuch as they break the lines of the body in the straightest portions, where there is no scroll to relieve them. For this reason crests or head plates are objectionable, and seem mere excrescences quite out of place: they encumber a plain sur-

face without compartments, and that in a mode which looks as though they had been rolled away towards one edge near the roof, in order to get them as far out of the way as possible. The practice is now fast disappearing. It originated in the desire to cover in some way the unsightly projecting hoop-sticks used to sustain the flexible heads of landaus, barouches, and other open carriages. In such cases the head plates had somewhat the same effect as the ornaments used by architects at the eaves of Grecian roofs to cover the ends of the projections which run in parallel lines down the joints. But on a plain surface, such as is presented by the upper panels of a coach or chariot, such ornaments are out of place.

The handles of the doors are always made conspicuous, being of brass or plated metal. Necessity dictates this, as the constant action of the hand in opening and shutting the doors prohibits the use of paint, on account of its rapid wear. The side of the carriage would look better without this prominent projection, if it could be avoided: but as that is impracticable, it is generally placed at the intersection of the central vertical and the central horizontal lines, where it interferes less with the outlines than it would in any other position. In some classes of carriages, such as dress coaches and chariots for town use, these handles are made highly ornamental, with a profusion of chased work; but in others they are left quite plain. The disadvantage attending chased work in carriages is the difficulty of keeping it clean. Its effect is dependant on the arrangement of bright and dead portions, and the latter cannot be preserved when the cleansing brush is fre-

quently applied. When polished metal is used, brass is the richest and warmest, and harmonises best with the generality of colours; but it requires much labour to keep clean, especially in damp weather. Silver is more adapted to many colours, having a cool appearance; but in winter it has the advantage of not tarnishing so readily as brass. Brass might of course be lackered to keep it from the action of the weather; but the lacker would give it a tawdry and unseemly appearance. Gold would be the desirable metal, were there not two strong reasons against its use— the expense and the temptation to robbery.

The most conspicuous objects in a carriage are the lamps. In dress carriages these are usually of polished metal, and there is much room for taste in them; but for travelling carriages the lamps are usually black.

In the lining or trimming of a carriage, form, colour, and proportion are all requisites. All dress carriages have hammer-cloths, or coloured drapery surrounding the driver's seat. This forms a most prominent object, and if it does not harmonise with the rest of the vehicle, the proportion of parts is destroyed. The general form of the outlines must be regulated by the lines of the iron-work or framework on which it is supported. The effect of it is architectural. It commonly has a base of deep lace or fringe; the central elevation is composed either of a panel work of cloth with lace outlines, or of massive cloth flutes; and the top has a capital of horizontal lace to surmount it. The size of the various parts, and the relative size of the whole to the carriage, must be regulated by the artist's eye; for so many considerations intervene, that no particular rules can be laid

down to follow out every detail. In brown and green carriages, it is customary to make the cloth or ground colour of the hammer-cloth the same as that of the body, and to relieve it with the differing shades occurring in the texture of the lace. But with other colour decided contrasts are preferred, not only in the carriage, but occasionally in the hammer-cloth itself. The design of the carriage builder is occasionally ruled by the family livery of the owner. Thus, sometimes a dark blue body is seen with a deep crimson hammer-cloth, a dead white hammer-cloth with a deep blue lace, and so on. Yellow carriages are sometimes fitted with blue hammer-cloths, and sometimes with drab ones; and the effect is equally good in both cases when well managed. In the formation of hammer-cloths to stand the rough usage to which they are constantly exposed in the ascent and descent of the coachman to the driving box, considerable judgment is required, to enable them to preserve their shape. A worn or defaced hammer-cloth destroys the general effect of the best made carriages.

The interior lining of carriages is regulated by the same general rules which determine the form, colour, and proportion of hammer-cloths, with the necessity for greater comfort superadded, which is made the first consideration. The form of the cushions and squabs must necessarily be regulated to the convenience of the passenger. These forms are regulated by means of the canvass and stuffing. The general covering is cloth; but for those parts which wear or are apt to get soiled, it is customary to substitute morocco or silk; thus one side of the cushions is cloth,

and the other silk or morocco, in order to reverse them if necessary. The vertical cushions at the back and sides, not being made to turn, are only covered on one side, with either silk or morocco. The roof is covered with cloth, as well as the other parts. The steps, which are made to fold into cavities in the doors, are covered with morocco and carpet. Pockets are arranged on the doors, and in a chariot, in front also. In carriages painted brown or green, it is very much the custom to use cloth of the same colour as the paint, and a different coloured morocco or silk. Thus, green cloth and crimson silk are not uncommon, or brown cloth and crimson or yellow silk. The lace which is used generally contains the same colours as the cloth and silk, and one of the colours is in relief. A breadth of three-inch lace is generally placed horizontally around the whole top as a kind of capital, and vertical lines descend from it on either side at the doors. The outlines of the pocket flaps are marked in the same manner, like a livery coat. The fronts of the seat cushions, and hanging loops for the arms, as well as the glass strings, are of the same lace. Along the seat a valant of vertically fluted cloth is carried, and the bottom of it is bound in a similar way. The other parts of the lining are bound with a kind of narrow edging lace. Different makers have different modes of trimming; some put more lace, and some less, but there is no exact rule on the subject, and the general appearance must be the principal guide to the artist. In the summer time it is customary to cover the lining with a false lining of chintz, generally striped, and sometimes in figured patterns. In this case no lace or binding edges are shown.

and the effect is very good. Formerly it was the custom to use brass or plated metal for the hooks, handles, glass rollers, and other mechanical arrangements; but ivory is now advantageously substituted, and in some cases pearl shell.

CHAPTER XV.

Varieties of Carriages.——Distinguishing characteristics.—Coach with Under-springs — Without Under springs. — Landau. — Driving Coach.— Town Chariot — Post Chaise — Landaulet —Britzschka Chariot —Elliptic Spring Chariot — Barouche —Barouchet.—Britzschka —Elliptic Spring Britzschka —Droitzschka —Driving Phaeton. — Elliptic Spring Phaeton — Pony Phaeton. — Britzschka Phaeton.—Ancient Phaeton — Cabriolet Phaeton —Elliptic Spring Cabriolet Phaeton —Curricle. —Cabriolet— Tilbury.—Stanhope.— Open framed Stanhope — Dennet.—Gig —One-horse Chaise, or Whiskey.

Not many years back, the varieties of carriages were very limited in number, and there was little room for the exhibition of taste in form. But this fault has of late been corrected, and the varieties of shape and make have become so numerous that it is difficult even for practised observers to be familiar with them all. The convenience of those who ride in carriages is now the first thing the builder has to study; and after that, to accommodate the form to it with as much of elegance as his taste will allow him to produce. Very ugly specimens are of course occasionally produced; but, on the whole, the increase of practice tends materially to the increase of good taste. Art has shaken herself loose from the trammels, and it is not surprising that she should make a few ungraceful gambols in the first burst of unrestrained energy.

Though it would be difficult to describe every particular variety of carriage now in use, it is comparatively easy to set forth the leading features,—the original models, as it were, of each particular class. The distinguishing characteristics are to be found in the form of the bodies, and not in the mechanism of the springs or framework. Thus a particular shaped body entitles a carriage to the term Chariot, whether it be constructed with under-springs or C springs, or with both, or whether it be with or without a perch. This rule obtains throughout the whole varieties of carriages; and in those bodies which are formed by a combination, it is customary to call them by a double name,—as, Cab-Phaeton, Britzschka-Chariot, Britzschka-Phaeton, &c.

The chief carriage of all, and from which the trade takes its name, is the Coach; though it is now little used as compared with other carriages.

A Town Coach, after the best models, is constructed with C springs and under-springs, hammer-cloth seat, Salisbury boot, and hind standards. The colours may be filled in according to taste.

The form of this body is agreeable to the eye. The central horizontal line should be straight in the middle, to correspond with the framing of the door, and the elbows should curve upwards into elliptic lines. The loops or hanging brackets should come outwards from the lower quarters, like the insertion of a flower-stalk. The rocker or false bottom beneath the bottom framing, intended to give greater height, scarcely show at all in perspective. The sword case, though a great convenience, is an ungraceful lump. The curved lines of the Salisbury boot are

pleasing; but the base line of the hammer-cloth, ranging below the elliptic curve, verging from the central horizontal line of the body, is a marked defect. The blocks on which the hind standard rests are usually rich and of graceful curve. The standard itself, though composed of pleasing curving lines, does not harmonise well with the outlines of the spring. The serpentine line of the perch, corresponding with the general outline of the body and loops, is very pleasing in its effects, but the under-springs are not graceful, being placed at two different heights. Wheels of differing heights are an anomaly. The C springs are pleasing lines, being in form about two-thirds of a circle, with a tangent for a base. The braces which connect them with the loops, and also with the body, are far from unsightly. If it be intended to use the coach for the purpose of travelling, the Salisbury boot and hammer-cloth are removed, and a platform substituted in its place, which carries a trunk inside, and an imperial on the top of it. The standard behind is also removed, and a boot on two light springs is substituted for it, capable of carrying two persons and a small box beneath their seat. At the back of the body is placed a cap-case, and on the roof either one or two imperials.

A reference to the drawing of the Town Chariot will enable the reader to comprehend this description.

A Coach of a simpler kind is devoid of under-springs. A platform in front, and a boot behind, are suspended on the C springs. To make a Town Coach of it, the imperials and cap-case are removed, and a hind standard substituted for the boot. In front, the platform is removed,

and a hammer-cloth seat is fixed to the horn of the loop by means of branch iron-work. To do all this work, of course, the C springs must be made larger and heavier than where the servants and luggage are carried on the under-springs. For the servants this kind of carriage is preferable, inasmuch as they ride on the same springs as their employers whereas in the other carriage they are commonly placed on the under-springs alone, which are hard and jar violently.* The total weight of this carriage is less than when under-springs are used; but it is much less durable and is harder to the draught, unless where the roads happen to be very soft. Coaches are not materially heavier than chariots in actual weight; but being constructed to carry a double number of passengers, of course additional strength is required. But they are not very pleasant vehicles, as they have no convenient look-out in front.

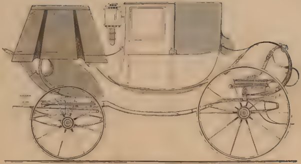
A Landau in its general form is similar to that of a Coach. But it is made with a jointed head to throw open occasionally. The two S formed irons which appear on the upper quarters are jointed levers for the purpose of holding the head firmly together when closed. It is usual to have a framed driving seat with a guard iron to this carriage, as it is more convenient; and when the head is down, it has a better appearance. But hind standards are occasionally used. Sometimes Landaus are made with under-

* The Macadamised streets of London, and excellent roads generally, permit of the use of springs which are found too hard on pavements and rough roads. The author has understood that English carriages with under-springs, when used in the streets of Paris, have caused French servants to spit blood, from violent and continued concussion.

springs; but their weight then becomes very great. The under side of the body is strengthened by very heavy iron-work to support it when open, and, of course, for a heavy body, heavy springs and heavy frame work are required. This is an expensive carriage to build, and very liable to get out of order, as the leather and wood work of the head is affected by cold and heat, damp and dryness. The expense of repairs is considerable.

A Driving Coach is a vehicle formerly much used by gentlemen fond of driving and attending race-courses. The perch is short and straight, and the wheels nearer together than in ordinary coaches. The body and boots are framed together, and suspended on telegraph springs before and behind,—the connexion with the carriage being by means of carved blocks. This carriage will carry four passengers inside—two on the driving box, two on the seat behind, and six on the roof, in all fourteen persons, besides possessing great space for luggage. This is a very convenient carriage for families travelling on the Continent. Sometimes this Coach is constructed as a Landau, to open; but the weight is much increased by it. It is an anomalous-looking vehicle, as the lines are inharmonious. The perch is straight, and the bottom of the body is circular; while every line of the boots and springs is straight. The form of the perch, and springs clearly indicate what the bottom line of the body ought to be, but in this, as in many other cases, habit prescribes. It would seem as though it could not be considered a *Coach* without a circular bottom line.

Plate No. I, represents a Town Chariot, generally esteemed above all others as a dress or court carriage when



TOWN CHARIOT

PLATE [illegible]

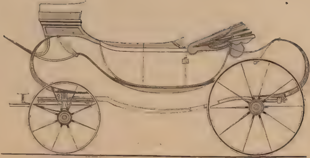
highly ornamented, though commonly used for other purposes. This carriage is by the French called a *Coupé*, being in fact a coach cut down; a portion of the fore end being cut away and only one seat left. The effect is pleasing; the lines of the fore end falling into each other in graceful curves, and the reduced portion above affording space for the lamp without interfering with the outline. In all other respects the carriage resembles the Town Coach before described, and is capable of the same alterations for the purpose of travelling, when it becomes a Post Chaise.—In this drawing the skilful observer will discover several defects. The front under-spring is too low down, and the distance is too great between the upper and lower curves. The front C spring does not rise gracefully from its bedding. The front body loop is not delicately tapered, and is badly set on to the body. The hind body loop is defective also, and the bottom of the Salisbury boot has no defined line. The bottom curve of the body is also unequal.

A similar carriage is constructed, without under-springs, and with a swinging fore and hind end; passengers and luggage being all borne on the C springs. The hind end has a boot for two servants; and the fore end has a platform, which can carry a trunk inside, and an imperial on the top. On the roof of the body is an imperial; and at the fore end of the body is affixed a large splashing frame covered with japanned leather, between which and the body is carried a cap-case. This altogether forms the regular Posting Chariot or Post Chaise. The lamps are black, and made to shift and hide the glass in the day-time. For

town use, the travelling furniture can be shifted, and a hammer-cloth seat and standard substituted. For persons who wish to lie at full length, the front panel can be taken away, and the fore end lengthened into a boot called a *dormeuse*.

A Landaulet bears the same relation to a Chariot that the Landau does to the Coach; and the remarks which apply to the Landau will apply to the Landaulet also—if possible more forcibly.

A Britzschka Chariot is distinguished from the ordinary Posting Chariot by the form of the body, the lower part of which is shaped something like a Britzschka. This is a very unsightly carriage; the lower lines being ungraceful curves, which do not harmonise with the upper part. But it is a very convenient carriage for travelling in foreign countries, especially for those who experience a difficulty in finding convenient beds, or who may be obliged to travel by night. There is ample room to lie at full length; and the step is placed outside, in order not to incommode the interior. A projection behind is adapted for bedding, and the front part is an elongation for the limbs. In addition to the ordinary lamps, a reading lamp can be attached behind to the back light,—an important convenience for travelling. One or two servants may be carried on the boot behind; and attached to the locker before is a board, which, when let down, forms a footboard; a seat being placed on the locker, an arrangement is thus made for driving. An imperial can go on the roof; and if the hind boot be taken away, one or two large trunks may be substituted. The front foot-board



BAROUCHE

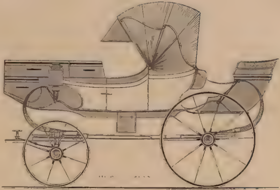
may also be let down to a horizontal level, and thus carry a large trunk. This carriage is much better adapted for diplomatic travelling than for family purposes. The roof can be made to open.

A light Posting Chariot is sometimes constructed on elliptic springs. This carriage is light, but not graceful, as the curved form of the body does not harmonise with the elliptic springs. The lockers before and behind are framed into the body, and form part of it. The seat is projected backwards from the hind locker, to allow the sitters' legs to go inside. The front locker is large and roomy, for the purpose of containing abundant luggage: an imperial goes on the top of it. The well beneath serves for a dressing-case, and other light articles. There can be a reading-lamp behind, and an imperial may be placed on the roof if required. The use of this carriage is to travel very rapidly with one pair of horses; but it is a noisy vehicle, owing to the rattle produced by the wheel-plate, which is communicated to the hollow boots, and thence to the body, with full effect. It may be considered a bachelor's or sportsman's carriage rather than one for family use, being well adapted for the purpose of leaving town and going to cover at a short notice.

The foregoing descriptions comprehend nearly every variety of vehicle known under the name of "close carriages." The varieties of "open carriages" are more numerous.

Plate 11. represents the principal of all open carriages, a Barouche. This was formerly a very fashionable carriage for the summer season, though little adapted for

winter, or for travelling purposes. Of late years Britzschkas have taken the place of Barouches, on account of their greater applicability to various uses. The body of a Barouche is usually made like that of the Coach without the roof. It is, properly speaking, only a town carriage, being unprovided with travelling furniture. The driving seat is similar to that of a Landau, and is intended for the coachman and footman to sit together, the hinder part being unprovided with a standard, which would be useless, as when the head is down there is little convenience for the servant's holders, and he would, moreover, be unpleasantly placed, looking down on the sitters within, and listening to all the conversation. The lines of the Barouche have for the most part a very graceful appearance; but there is a striking defect in the hinder quarter, which, owing to the dark head, appears much smaller than the front, while it is in reality of the same size. This gives the body something the appearance of a ship going stern foremost, "cutting the waves with her taffrail."—Another defect is the door-handle, which breaks the surface of the panel in an unpleasing manner. For the purpose of shortening the carriage and getting a high fore-wheel, the front quarter line is sometimes turned sharp up from the door line, and arched in a serpentine form, to give more space beneath. This is called a "step-piece body." It is advantageous as regards the mechanism, but exceedingly ungraceful, and moreover inconvenient, as it interferes with the leg-room of the sitters. The Barouche has two seats, like a Coach; and when the head is thrown back and the knee-flap elevated, it will hold four or six persons



BRITZSCHKA

inside; but in wet weather only two or three can be accommodated, or the lining will be spoiled by the rain, and the passengers wetted. Occasionally, to remedy this inconvenience, the carriage is fitted with a mahogany roof and sides, to close against the head, and provided with glass windows. But this is a miserably inconvenient expedient, and exceedingly unsightly. For fine weather the Barouche is one of the most delightful of all carriages. It is sometimes made with under-springs; but the effect is not so good, as it then makes a heavier appearance. Much of the beauty of the Barouche depends upon its light exterior. Of course it is not so light as it appears, owing to the bottom strengthening plates.

There are several defects in this drawing. The broad upper moulding shows a broken line; the back elbow line is the same; the back quarter line is defective, and the front loop and the stay branching from it to the footboard are clumsy and ungraceful.

A Barouchet is to a Barouche what a Landaulet is to a Landau, and the same remarks apply to both. The Barouchet is, however, generally constructed as a very light carriage of small size, to be drawn by one horse. It is now but rarely built, as much lighter carriages can be constructed with the elliptic springs so commonly in use. The Barouchet is not a graceful carriage.

Plate III represents a Britzschka. It is little more than ten years since this carriage, or rather the original model of it, was first introduced from Germany; and now, after many succeeding modifications, it has become the most common of all carriages. The reason of this is its

exceeding convenience, and adaptability to a great variety of purposes. This drawing shows a Britzschka after the best models, as adapted for travelling. The body and seats all swing alike on the C springs. The boot behind will accommodate two persons. The body, when the knee-flap is open, will hold four; but in wet weather it is only fitted for two. The step is outside, to leave the interior less cramped. The front part of the head has a calash attached to it, which is easily put up and down; whereby the facility of entrance is increased, as the head does not slope too far forward The access of rain is thus carefully guarded against; and in case of cold weather, there is an ingeniously contrived glass shutter, which folds up in a recess of the head, and which when let down will fill the whole front, closing with an air tight joint in the front of the knee-flap. The sword-case behind is large and convenient; and the leg-room in the interior is abundant for reclining at full length if necessary, when constructed without a front seat in the interior. The front trunks can be taken off and replaced by a driving-seat.

The lines of this carriage are pleasing to the eye and harmonise well together. The marked distinction between this and the foregoing carriages is the adoption of a straight bottom line. This, and the end curves, together with the deep panel behind and the long elbow sweep before, tend to give it a ship-like and fast-going appearance; while the foot-board in front points the line of progress. The sword-case is unpleasing in its outline, beauty having given place to convenience The lamp is well arranged for use.

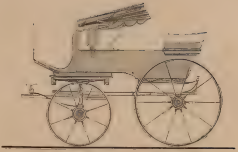
A defect in this carriage is the unequal size of the front and hind springs. The motive is to balance the weight more equally. This defect would have been more perceptible had the largest spring been in front; but the small wheel and small spring being together, the defect is lessened. What adds very much to the general good effect of this carriage, is the broad elbow line, which forms a distinct outline, like the shear line of a ship.

It is said that the first German Britzschka was brought to England by the Earl of Clanwilliam, who liked it for its lightness; for which reason it probably obtained, amongst coachmen and mechanics, the translated name "Brisker, or Brisky." But the German carriage was light, being intended only for three persons, with little luggage; therefore its low wheels were not a very serious objection. English convenience afterwards required that greater accommodation should be provided both for persons and luggage; but the carriages, though they have attained great convenience, combined with grace, have become in reality as heavy to the draught as ordinary Posting Chariots. Some of them are now occasionally made with additional under-springs, like the Chariots. This increases the weight and height at the same time. Owing to its movable head and greater exposure of the lining to the air, the wear is considerably greater than that of a Chariot.

There are two slight defects in this drawing, — the curve of the hind spring, and the bottom line of the body.

Britzschkas are also made without a perch, and supported on elliptic springs. The locker behind has a door to put in luggage. It is also sometimes made to open at the top, to form a servant's seat. In this case, the front seat can be taken away, and a cap-case and imperials substituted for it. This carriage has a pleasing light appearance in its general lines; but in the fore part there is a great defect of construction. In the hind part, the body rests on a curved block, which is bolted to the centre of the spring. In the fore part, there are two curved blocks on which the body rests, but instead of being placed over the centre of the spring, or the wheel-plate above it, they are usually placed behind, whereby a considerable amount of mischievous leverage is produced, and a most unsightly effect, which must immediately become apparent to a practised eye. This kind of carriage is calculated to run very light, but must necessarily be very noisy.

A Droitzschka—or, as it is commonly called, a Drosky—was in the outset of Russian origin; being in fact in its simplest form an improvement on the sledge, by adding springs and wheels, the single passenger sitting with his legs on each side of the perch, as he would sit on a horse. But the Droitzschka as made in England is a modification of the elliptic spring Britzschka, by placing the passengers' seat nearly at the level of the hind axle, and sinking the central part of the body below the level of the axle, for the legs. This carriage can only carry two persons inside, and two on the driving-seat. The form of it is not graceful; neither is the carriage convenient, as the space inside for the legs is cramped by the necessity of shortening it in



MODERN PHAETON

front to allow the fore wheels to turn under: and while it appears light, it is in reality very heavy for its size, the peculiar form necessitating very strong iron-plates to hold it together. The principal utility of the Droitzschka is for languid, aged, or nervous persons, and children, as it is low on the ground, and consequently easy of access and difficult to turn over. It is made for one horse, or two ponies, but is very heavy to draw.

Plate IV. represents a double-bodied Driving Phaeton, which was at one time in very extensive use, but has been much superseded by the Britzschka. This carriage is not very graceful, the front and hind springs assorting ill together, and the long black locker looking too like a coffin. It is, however, a convenient carriage either for town use or for travelling, being light and having proportionately large wheels. It is generally used in town by those who like to drive themselves; for which reason the best seat is placed in front. But the seats are sometimes made to shift, in order that a servant may drive in bad weather. It is only intended to carry four persons. For travelling purposes, a large box is placed under each seat, and one behind the front body: one also is suspended behind the back seat. Like all open carriages, of course, it wears out faster than a close one. The position of the lamp disfigures the panel; but it is the most convenient arrangement, and appearance cedes to utility. The springs are now usually connected by short leathern braces instead of iron links, in order to reduce the noise.

A Phaeton of the same class, but borne on elliptic springs, and without a perch, is in common use. It is consequently

much lighter, and altogether less noisy, as the springs work together on smooth centres; but the noise from the wheel-plate is greater than in the other mode of suspension. The fore carriage and springs are attached by carved blocks in the same defective manner as the under-spring Britzschka before described, and consequently the same unsightly appearance is produced. This carriage is the very simplest form of four-wheeled vehicle in ordinary use. It is literally a long box, with an arm-chair in front, and a bench behind. An arch in the locker is usually contrived, to permit the fore wheel to pass beneath, and thus allow it to be somewhat higher. This convenience is attained by means of cramping the servant's leg-room.

Pony Phaetons of a Cabriolet form were at one time very fashionable. They are intended for two sitters, one of whom drives, and a boy may be seated on the bar behind if required; or a boy may ride as postilion on one of the ponies. The form of the half-curved body is graceful, with the exception of the straight lines of the seat. The branching iron stays, which connect it with the springs and wheels, are also well managed after the pattern of the growth of the tendrils of flower-stalks. The lines of the hind spring also fall in well with the curl of the stay. But there the beauty ends. The step is unsightly, and the front framework looks like a mass of disproportioned parts. The small fore wheel and the low fore spring are seen in all their defects, being unrelieved by a driving-seat. It appears at first sight that this carriage is light and easy to draw; but such is not the fact. The space between the fore and hind wheels is considerable, and con-

sequently the branching iron stays, which are in reality crane necks, must be very stout and heavy, to resist the strain upon them. These carriages are principally used for parks, where ladies drive themselves.

A Britzschka Phaeton rests its claim to the title of Phaeton on the mode of hanging; the springs being precisely on the same principle, though not in the exact form, as those used in the Phaetons of the last century. The body is a modification of the Britzschka, and of rather more elegant form. The drooping of the lines from the front seat gives a pleasing effect, while the elevation of the hind seat above prevents any nakedness of appearance. The seats are constructed to shift at the pleasure of the owner. Two persons can sit in front, and two or four behind, according as the head may be shut or open. The step is made to slide under the bottom, as an outside step would much disfigure this form of body, and to fold it up inside the door would be inconvenient. The object of using the double springs in front, instead of the C spring, is to have the space perfectly free for ascending the front seat without inconvenience. But the motion is far from pleasant, as the points of the front springs form a centre, around which the hinder part of the body moves in an arc of a circle as it sways up and down, instead of an agreeable horizontal motion. This carriage, though elegant in appearance, is heavy. If used for travelling, it could carry little luggage, as there is no seat behind. Consequently, a trunk behind, and a box under each seat, would be the total amount.

A monstrous-looking vehicle was known under the name

of a Phaeton at the end of the last century, and the commencement of the present. What connexion there could be between this vehicle and the fabled car of the Sun-God, to obtain for it such a title, it is difficult to conceive. It was at one time a most fashionable vehicle, and the favourite driving carriage of the Prince of Wales, afterwards George the Fourth. The object in alluding to it here, is to serve as a standard to show the great progress which a comparatively short period has developed in the art of the carriage constructor. The vehicle looked like a mechanical illustration of the play of "Much ado about Nothing." It was a contrivance to make an enormously high and dangerous seat for two persons, inconvenient to drive from, and at the same time to consume as much material and mix up as many unsightly and inharmonious lines as possible. The framework of the carriage was constructed with two iron perches, the outline of which was hideously ugly; but the camel-looking hump had at least the mechanical advantage of permitting a higher fore wheel than could otherwise be used. The shape of the body was as though the rudest possible form capable of affording a seat had been put together. An ungraceful form of upright pillar or standard was first selected, into which was framed a horizontal ugly curve for a seat, connected at the top by an ungainly-looking elbow, and a formal serpentine curve behind, from which was projected like an excrescence an ugly leathern box called a sword-case. The front of the upright pillar was continued into a most formal curve, and from its point rose an ungraceful bracket, to support a foot-board, on the extreme edge of which was coiled an ugly piece of leather called

an apron The construction of the body was such that it could not possibly hold together by the strength of its own framing; and to remedy this, a curved iron stay was introduced in the worst possible taste. The leathern head rose from the body at an angle which seemed to indicate that it could get no rest, and the black box or locker introduced to fill up the under part of the body was made with straight lines, as if to make the whole still more heterogeneous and unsightly. The huge double curved hind spring, with its leathern brace, was so contrived as to occupy one half of the total length of the vehicle, and the odd-looking stay which prevented it from falling over in front, marked its total insecurity. The crooked-shaped iron loop which connected the body with the brace looked as though it had been partly wrenched away by violence, and were waiting repairs. The fore springs rather resembled the flourishing strokes made by a schoolmaster, when heading a copy-book or Christmas piece, than any legitimate mechanical contrivance; and the motion must have been detestable, rendering the act of driving difficult, and lessening the power of the drivers over their horses. The servant's seat behind, placed on curved blocks without any springs, completed this extraordinary-looking vehicle. To sit on such a seat, when the horses were going at much speed, would require as much skill as is evinced by a rope-dancer at the theatre. None but an extremely robust constitution could stand the violent jolting of such a vehicle over the stones of a paved street.

A Cabriolet Phaeton is made with C springs behind, and double-lever springs in front. The shape of the body

is elegant; but this is its only advantage, the defects of the springs being the same as in the Phaeton last described. This carriage is heavy, and the fore wheels low; it is used principally to drive from, but sometimes with a boy mounted on one of the horses.

A Cabriolet Phaeton is also constructed on elliptic springs, without a perch. From its great convenience this carriage has been very much used. The seat in front is conveniently high to give command over the horses; while the seat behind is low, and gives great facility of access. But it is not possible to give the lines of this carriage an elegant appearance without making it very long and heavy; and even then the fore wheel must be kept small, to enable it to turn. When made short, the straight lines of the fore body and the curved lines of the hind ones can in no way be made to harmonise. It is a light vehicle, though not so light as it appears, and will carry four persons—two on each seat.

There are various other four-wheeled carriages constructed and known under different names, either of simple or compound forms, some hermaphrodite, and some nondescript; but those already described are sufficient for all practical purposes. The range of invention is of course very wide, and the artist or mechanic may modify or improve according to will and capability.

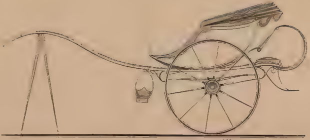
The two-wheeled vehicles are less numerous than those with four.

The Curricle is the only two-wheeled carriage used with more than one horse abreast, and therefore approaches nearest in its mechanism to the antique classic Car. In

form, however, it is very different. The shape of the body is extremely unsightly. The hinder curve and the sword-case are positively ugly. The elbow and head are ungracefully formal, and the crooked front line and dashing iron are in the worst possible taste. The lines of the carriage framework and under-spring are graceful; but the mode of hanging the body is unsightly and inconvenient. The step preserves the general formal character of the whole vehicle. The mode of attaching the horses is precisely that of the classic Car, only more elegant. A pole is fixed to the square frame, and is suspended from a bright steel bar, resting in a fork on each horse's back. In spite of the ungraceful form of the vehicle, the effect of the whole was very good. A seat for a servant could be attached to the hind frame if required. This carriage fatigues the horses much less than one with four wheels, on account of its superior lightness; but it has been wholly disused of late years, probably on account of the risk attached to it if the horses become restive. The whole of the security depends upon the strength of the pole, which serves as a lever to sustain the weight of the vehicle and passengers, as well as to guide it. It is not essentially necessary that the vehicle should be ugly in its form; for it affords facilities for constructing the most elegant of all vehicles.

A Curricle of another form was built many years back for the well-known Mr. Coates. The shape of the body was that of a classic sea-god's car, and it was constructed in copper. This vehicle was very beautiful in its outline, though disfigured by the absurdity of its ornamental work.

Plate V. represents a Cabriolet, a vehicle much used in the present day. It is in reality a regeneration of the old One-horse Chaise, in a newer and more elegant form, which has been borrowed, together with its name, from the French; and, as is common in most such cases, it has been improved on. The principal reason why this carriage is so much liked, is its great convenience. It carries two persons, comfortably seated, sheltered from sun and rain, yet with abundant fresh air, and with nearly as much privacy as a close carriage, if the curtains be drawn in front. It can go in and out of places where a two-horse carriage with four wheels cannot turn; and a boy is carried behind, cut off from communication with the riders, save when they wish to alight and give the vehicle into his charge. This is a very convenient vehicle for unmarried men to go out in at night, and return either from a dinner, or from the theatre or opera, or houses of parliament: it saves the inconvenience of a close carriage, two horses, a coachman and footman, which, when out late at night, involve a large amount of trouble as well as expense. The drawbacks are, its great weight,—which requires very powerful and expensive horses,—and the unpleasant movement arising from its mode of hanging. To run a Cabriolet about town during a whole day, two horses are required; and to use it day by day requires three in use. But this fact gives a Cabriolet greater estimation than a Stanhope, in the eyes of those who regard it as an indication of station and wealth. It is, however, an impracticable vehicle for those who wish to drive out of town frequently, ten or twelve miles and back. Another disadvantage is the un-



CABRIOLET

LATE

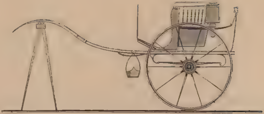
pleasant motion consequent on the mode of hanging the body. To some persons this motion is excessively disagreeable. As Cabriolets are much used at night and are driven at a very rapid pace, many accidents have happened, in consequence of which some of those who use them have adopted the practice of hanging bells round the horse's collar, as is done in many countries where sledges move rapidly and noiselessly over the hardened snow. On paved streets the Cabriolets make noise enough, but on those which are Macadamised, two of them may run foul of each other at night before the sound can efficiently warn the ear.

The peculiar feature of the Cabriolet is the graceful form of the body, which resembles that of the nautilus shell, and with which the shape of the head harmonises well. The dark portion in front shows the side of the knee-flap, which, instead of being flexible, as in the old-fashioned aprons, is stretched tightly across a frame, to the great convenience of the sitters. The lamp in front is usefully placed, but it is unsightly, and harmonises ill with the shape of the body. The shaft forms a graceful curve, and the spring behind falls well in with it. The spring beneath the shaft also is well adapted to the line. The straight leather brace which connects the spring with the loop behind, looks defective and formal. The step looks what most steps do—an excrescence, and the wheel appears small when compared with the size of the vehicle: but necessity rules this. The wheel must be kept so far back as not to interfere with the access to the vehicle; and the axle must be kept so far forward as to balance it

correctly, without throwing too much strain on the horse's back. Other modes of construction might be adopted which would prevent the necessity of avoiding one fault by creating another. The motive for curving the shafts so considerably, is to have the point at the level of the horse's shoulder, and keep the hinder part low for the convenience of the passenger.

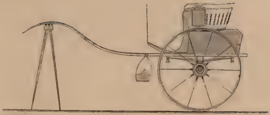
The defects in this drawing are, that the bottom line is too much curved, the front point throws up too much, and the hind spring is not delicately enough tapered.

Plate VI. represents a Tilbury. This vehicle was first invented by a carriage builder of that name, and was for many years very fashionable. The probable reason for its being liked, was its apparent lightness. In all other respects it is an unsightly vehicle, and the mode of hanging is still worse than that of the Cabriolet. The action on the cross spring behind has a tendency to twist it. The dark portion under the seat represents a drop-box, which in the construction has a still worse appearance than in the design, while without it, the body looks as though it were temporarily put together and never finished. The motion of the body is most unpleasant, and lessens much the command of the driver over the horse. Originally these vehicles were built without springs between the shaft and the axle, instead of which a deep carved block was used; but the jar was so great, that springs are now always substituted—*i. e.* for the few which are made, for the disadvantages of this mode of construction are now becoming more obvious as the art of carriage building advances. While apparently light, the Tilbury is in reality the hea-



TILBURY

PLATE V



STANHOPE

vast two-wheeled vehicle which is constructed, except the Cabriolet. It has altogether seven springs, and a considerable weight of gibbet-looking iron-work besides, to support the hind spring. In addition to this, massive iron plates are attached all round the framework of the body, to hold it together and resist the strain upon it.

In this drawing the central horizontal line of the body is distorted, the under spring is too straight, the step is too upright, and the general appearance of the body too formal.

Plate VII. represents a Stanhope, taking its name from the inventor, a brother of the Earl of Harrington. This is a far more sightly and compact vehicle than the last. The body is in reality of the same shape as that of the Tilbury; but, resting on the dark locker, the space is agreeably filled up, while great convenience for luggage or parcels is obtained. It rests on two cross springs, whose ends are suspended from two side springs. By this means the body is placed at two removes from the concussion; but the shafts, and consequently the horse, are exposed to the whole of it,—over the stones this is considerable. The connexion between the side and cross springs was formerly merely by links, as in ordinary stage-coaches, from whose construction the idea was taken; but the jingling noise soon caused noiseless shackles to be contrived, working on smooth centres. When these shackles become galled, of course they must be replaced by others. Of late, short leather braces have been substituted for them, as being less noisy, and yielding greater freedom of action to the springs. One defect of this construction is, that

if the horse falls on his knees, a violent jerk takes place on the front cross spring, which yields, while the hind spring offers no resistance, and the consequence mostly is that the riders are pitched out.

In this drawing, the springs, instead of a graceful curved line, look as though they had been forcibly bent in the centre; and the hinder part of the shaft looks as though it were weighed down.

Another variety of the Stanhope, adapted for town use, has the light look of the Tilbury, with less real weight than the ordinary Stanhope. A pleasing open outline is given; and the upper part of the body, round the seat, being wrought with a network of cane, has an agreeable effect, especially for fine weather. The open part beneath is not unsightly, and, if required, can be filled in with a drop-seat box for the purpose of carrying parcels or luggage. In such case, this vehicle is well adapted for a summer tour.

A Dennet has a body resembling the Phaeton in Plate II. Instead of four springs, the Dennet has but three,—two at the sides, and one cross spring behind. This vehicle is easier for the horse, as it is lighter, and the shafts rest on the side springs at their front points. For this reason the hackney Cabriolets of the streets are thus constructed. But they are uneasy to the passengers, on account of the unequal motion; and if the horse falls, the danger of being thrown out is greater than with a Stanhope. The origin of the name the author is unacquainted with, but he has heard that the three springs were thus named after the three Miss Dennets, whose elegant stage-

dancing was so much in vogue about the time the vehicle was first used.

The vehicle formerly known as a Gig was the lightest one-horse vehicle used in England. It is simply an open railed chair, fixed on the shafts, and supported on two side springs, the hinder ends of which were connected to the loop irons by leathern braces to give more freedom of motion. The wheel was larger and the body kept higher than the Stanhope; for which reason the shaft required less curvature.

This vehicle ran exceedingly light after the horse; and the shafts were usually of lance-wood, to give sufficient play. The side-springs were long and easy, and the whole vehicle was well adapted for travelling purposes, the space underneath the seat conveniently holding a portmanteau. Occasionally they were used for sporting, when the locker was made with Venetian blinds to carry the dogs, and then it became a "dog-cart." The American sulkies are constructed on this plan, but without springs, and with higher wheels, to carry one person. Their total weight is from eighty to ninety pounds.

The old One-horse Chaise, or Whiskey, was as heavy as the modern Cabriolet, without its grace of form.

The defects criticised in the drawings are not original errors of design, but have arisen from technicalities of execution not within the author's control.

CHAPTER XVI.

Purchasing and Jobbing Carriages.—Carriages made to order.—Ready-made Carriages.—Judgment.—Preservation of Carriages.—Sun.—Frost.—Rain.—Dust.—Mud.—Atmospheric Air.—Moisture.—Dryness.—Metal-work.—Rust.—Leather.—Cloth.—Silk.—Lace.—Paint and Varnish.—Coach-houses.

WITH very few exceptions, it is to be supposed that the greater number of those who can afford to indulge in the luxury of carriages are desirous of enjoying them on the most economical terms, consistent with good taste, not merely as an economy of money, but also of time and convenience.

There are three modes of obtaining the use of carriages. First, by hiring them for short periods, as a few weeks or months; secondly, by taking them on lease for a term of years; thirdly, by purchasing them outright, either ready-made, or made to order.

The first method is the most expensive, and at the same time the most inconvenient, as they are generally inferior carriages, and charged at a high rate to make up for the uncertainty of their being occupied except at intervals.

The second method is far preferable, as the builder, by making sure of the consumption of his commodity during a term of years, can afford it at a lower rate of profit; and the customer has the advantage of a carriage built to suit

his own taste and convenience, knowing at the same time the total amount of his expense for it for a certain term, without any anxiety as to repairs. The usual plan is, for an agreement to be entered into between the builder and the customer for the term of four or five years, the carriage to be once painted during the period, and found in all needful repairs, including wheels; but the customer is responsible for all accidents. At the end of the term, the carriage becomes the property of the builder, who sells it, or perhaps enters into a new arrangement for three years longer, at a reduced rate. A gentleman taking a carriage on this plan, has all the advantages of a ready-furnished house. It is essentially his own so long as he needs it, without causing him any anxiety; and on the average, unless of methodical habits, it will be a pecuniary saving to him. He might certainly buy a carriage for about the same price as four years rent' would amount to, and at the end of the time he would have a second-hand carriage to dispose of, but during the whole time the expenses of repairs would fall on him: and of course he must be at the trouble of directing his servants, and ordering his own repairs. He in fact takes all the responsibility, and relieves the coach-maker from it.

The third method—purchasing—is most for the interest of the coach-maker, as he needs less capital to carry on his business, and also of the purchaser whose habits are regular. But in some large establishments where immense capitals are employed, large premises are kept with a view to carry on the system of jobbed or hired carriages, and it is indifferent whether the customer purchases or

jobs. There are some establishments where no carriages are ever built except to order: there are others, again, where few are built to order, and large quantities on speculation. Occasionally, good carriages are built on the latter plan; but as a general rule they are decidedly inferior. The reason must be obvious. Carriages require considerable capital for their construction; and being articles of taste as well as convenience, their sale is uncertain. Moreover, the rate of profit on an expensive article is always smaller than on articles of little outlay. Therefore, those who build carriages on speculation naturally cut down their outlay all they can, and not unfrequently use inferior materials, which could not be at all employed in carriages made to order by those desirous of maintaining professional reputation. A large portion of the carriages got up for sale are of not only inferior materials, but of inferior workmanship. Like Hodge's rasors, they are made to sell. Poor men out of work get credit for materials and put them together "anyhow." They then stand them in some place of public sale, and reap a bare living at most; the heavy expenses eating up their profit, and frequently encroaching on the prime cost. Those who purchase them as bargains find too late that they are bitten, when, after a fortnight or three weeks' use, they are obliged to send them at a heavy expense to be repaired, or perhaps half rebuilt. The fact is, that all locomotive vehicles are exposed to severe tests; and the badly-built carriage has to sustain the same trials as that which is first-rate. Plaster and ornament may conceal the defects of a badly constructed house for a long period, but a carriage,

like a steam-engine, is required to perform *work*, and thus the defects must become apparent.

Of course there are good carriages to be purchased ready-made; but, generally speaking, the purchaser is ignorant how to distinguish the good from the bad. If the purchaser be skilful in detecting the faults of carriages and possess accurate judgment as to their excellence, he can go into the market and purchase the best, at the lowest price for which it can be obtained. If he be also a man of taste, he will know how to select an elegant form without being confined to any particular build. But few carriage purchasers possess these advantages, and therefore the wisest way is to pay a higher price and secure the best commodity. As carriages are articles of taste as well as convenience, he who merely requires convenience may go cheaply to work; but whoever requires taste in addition, must in fairness pay an additional per centage to the artist. If a person ignorant of mechanism were to require a watch for astronomical purposes, in which accuracy were paramount to all other considerations, his wisest course would be to pay the highest price; and thus, though he might pay more than was absolutely necessary, he would at any rate secure himself against disappointment in his commodity. And thus it is with carriages. We may use our judgment in that which we understand, but when our judgment is at fault, we must trust ourselves in the hands of those who are of most repute in the matter.

After the purchase of a carriage, the next consideration is, how it may be best kept in order and preserved from the various atmospheric and other influences which tend

to destroy its beauty and utility. To ascertain this, we must remember the numerous materials which enter into its composition,—wood, metal, leather, wool, hair, cotton, silk, linen, paint, varnish, &c.

Carriages are used in the open air, in sun, frost, rain, dust, and mud; and all have a tendency to destroy their beauty. The general temperature most congenial to the durability of the carriage, is that of the workshop in which it has been constructed. In atmospheric air of a given composition as to moisture, wood possesses a certain standard of bulk. If it be removed to an atmosphere of greater moisture, it increases in bulk, or swells: in one of less moisture it shrinks, and is apt to crack. To resist this tendency, all the wood used in carriages is well covered with paint, the surface of which will resist moisture. But as the covering of paint is rarely perfect in all parts, moisture will at last find its way to the wood, if care be not taken; and so also, if the carriage be placed in too dry a situation, the panels will split, just as a ship's decks would leak if not wetted several times a day during the heat of the sun. This should be a rule also with carriages in very hot weather, and especially with their wheels.

The metal-work of carriages, on the contrary, sustains no injury from heat, but much from moisture. Iron and steel especially suffer. Where the paint happens to be chipped from the surface of iron, rust seizes it, and gradually insinuates itself beneath the whole covering of the paint, which strips off in flakes. Beneath the surfaces of the spring plates also, rust is continually working damage, and disfiguring their beauty with dirty brown lines on the

exterior. The plated and brass work about the carriage also suffers much from damp.

Leather suffers equally from exposure to sun and wet, and in compound proportion when alternating between the one and the other. Toughness and tenacity are the qualities principally required in leather for carriages; and these qualities depend principally on the presence of a certain quantity of oil or fatty matter, which the leather imbibes like a sponge. On this matter the oxygen of the atmosphere acts strongly, and at length consumes it entirely, and if it be not renewed, the leather cracks. If the leather be exposed to wet, this process is still more rapid; but when leather is frequently oiled, it is apt to look dull, and occasion much trouble to the coachman, who prefers blacking it, and the materials of which the blacking is composed tend to the decomposition and destruction of the leather. Leather which is painted or japanned possesses little or no tenacity, and is never oiled. The patent grained elastic leather which has been so much used of late for heads and knee-flaps is a very beautiful substance to the eye, and is quite water-proof so long as it is free from cracks; but if exposed long to heat, it is apt to crack. Also, if one portion of the surface be kept some time in contact with another portion during warm weather, it is liable to adhere and strip away. When cracks take place in it, the water gets in and it rots rapidly. Altogether it is preferable to oiled leather for heads, if ordinary care be used: for although it will not last so long, the saving of labour is very great, and the appearance is greatly superior.

The cloth, silk, and lace, composing the lining and hammer-cloth generally, combined with wool, hair, cotton, and linen, suffer from the sun's rays by losing their rich colours, and from the damp by becoming mildewed and rotten. The cloth, hair, and wool suffer from another cause—moths. In open carriages this last is a very serious evil. The patent India rubber cloth now so much used as a waterproof cover for hammer-cloths has the same effect on the moth as cedar shavings; but it is impossible to use it much for inside work, as the odour, especially in warm weather, is very unpleasant. It would seem a desirable thing, however, to introduce a portion of cedar shavings into the stuffing of the linings.

Paint and varnish suffer little from simple damp, unless it be salt water, which is very destructive. But heat, especially that of the powerful rays of the sun, is very destructive to them. The colour changes, and the lustre of the varnish disappears amidst a multitude of intersecting cracks; and to restore the beauty, there is no remedy but repainting. Another mischievous influence to paint and varnish are the various gaseous bodies to which they are exposed. It is customary, for the sake of convenience, to stand carriages close to the horses' stables, generally in a mews, where large muck-heaps are piled up in all stages of fermentation. During this process, various gases are evolved, which act on the varnish much in the same way that nitric acid acts on copper; though fortunately they reach the varnish much diluted with atmospheric air.

It must therefore be clear that such coach-houses as are at present commonly used are not the best that could

be adopted. The materials of a carriage are as delicate, and require as much care, as the furniture of a drawing-room; and therefore they should be as carefully preserved from stable contact as the satin couches of the drawing-room. After the carriage has been out, whether in the sun or the rain, it should be carefully washed, and, above all, dried, taking care to wet the leather as little as possible during the operation. It is a common practice to wash the carriage, and then leave the water to drip away. After drying, the leather, and especially the braces, should be slightly rubbed with an oily rag to restore all that had been consumed in the day; and the carriage should then be placed to stand in a dry well-ventilated apartment with a boarded floor, leaving a clear passage for the air beneath it, and, if at all convenient, having warm air passing through to ensure its dryness. Above all, it should be away from all stables, dung-heaps, cesspools, or open drains. A gentleman should avoid placing his carriage in any situation where he would not wish to place his wardrobe; and with regard to the interior lining, he should treat it much in the same manner. If the carriage be laid by for a time, it should occasionally be brushed out, and have a current of warm air passed through it. Cedar shavings should also be placed in it. If an open carriage, it will require more care than a close one. The hammer-cloth should be covered with the water proof India rubber material, and cedar shavings should be interposed between them. The blacking should also be washed off the leather work, and a composition of oil and tallow rubbed into it to preserve it. The iron-work should be kept

painted wherever it may have been chipped, and the whole of the wood-work, and especially the wheels, frequently washed over with water,—this more particularly in the summer time. The metal-work should be cleaned occasionally with whitening or plate-powder, and rubbed every day with a soft leather: it will thus last much longer than when it is suffered to tarnish frequently. If common axles, they should never be suffered to run more than seventy or eighty miles without fresh greasing. If mail axles, they should be looked to when new every three weeks;—if old, every week. If the patent oil axles, they will run between three and four thousand miles without fresh oiling; and when this is done, it is better to send for the carriage-builder or engineer to do it, if practicable, than to trust to a servant, unless he has been previously well instructed in it. The wheel-plate will also require occasional greasing, and new leather will be required to the transom. The suspending braces should also be carefully watched, as they are apt to cut and strain at the eyes and angles. A carriage carefully attended to in this manner will yield one third more service than one which is neglected.

CHAPTER XVII.

New Inventions.—Imperfections of English Carriages. Unequal Wheels. Unequal Motion, unequal Wear, unequal Durability.—Elastic and Rigid Wheels. Modes of making Spring Wheels. Author's Invention of a Circular Spring Wheel. Improved Oil Chamber. Author's Invention of Equirotal Carriages.—Equirotal Phaeton.—Advantages of the equal Wheels.—Equirotal Cabriolet Phaeton.—Equirotal Pony Phaeton. The same with a low body.—Equirotal Droitzschka.—Equirotal Chariot; advantages.—Equirotal Carriages adapted for Posting with one Horse, being very light.—Equirotal Omnibus, advantages.—Author's Invention of an Adjusting Bow Spring, adapted equally for light and heavy loads in Carriages, and universally applicable.

Cabriolets and Omnibuses. Hansom's Cabriolet.—Association Omnibuses.—Patent Cabriolet, with door behind and Boulnois' Elliptic Springs.—Defects of the Patent Cabriolet.—Imitations.—Go-carts.—Four-wheeled Cabriolet.—Deep-cranked Axles.—Author's Invention of a deep-cranked Axle.—Author's Invention of a Cabriolet open or close at pleasure, and driven from behind. Author's Invention of a Coal and general Burden Waggon, adapted to narrow Streets and Wharves.

It has been asserted in print, that English pleasure carriages are in their present condition specimens of perfection in the art of locomotion with animal power; and very many persons there are ready to attest their belief in this. It is, in short, a common error, the source of which is not difficult to discover. English carriages, take them altogether, are the most perfect carriages constructed in any part of the world, and the mistake has been in confound-

ing high superiority in existing art with absolute perfection. To show that English carriages are still far short of perfection will be no very difficult task.

"A large wheel following a smaller one without being able to overtake it," is the description applied by some quaint author to a carriage. Herein consists the source of the principal part of the defects of carriages.

If two axles be made permanently parallel in a carriage, it is evident that carriage can only advance in a straight line, and that all power of turning will be precluded, unless by a sliding motion instead of a rolling one; and even then it can only turn in a very large space. To obviate this difficulty, the front axle-tree is made to turn on a central pivot called the perch-bolt. But inasmuch as the body is made to hang between all four wheels, whenever the front axle turns or is placed at an angle with the hinder ones, the front wheels must necessarily strike against the body. To remedy this second evil, the front wheels are so much decreased in size as to pass beneath the body; and thus a third evil is created, of so great magnitude, that to alleviate it as much as possible a fourth evil was devised; viz. to raise the body to a greater height, and thus permit a larger wheel to pass beneath it. The centre of gravity was thus made higher than before. The last evil has occasionally been remedied by a sacrifice in the form of the body; viz. cutting away a portion of the front under part, in the form of what is technically called a "step-piece." The numerous general defects of form incident to the unequal size of the wheels have been already dwelt upon. The great mechanical defects are unequal motion, and consequently unequal wear, and decreased durability of the

machine, together with want of ease to the passenger, and an abundance of noise, arising from the necessarily defective construction incident to a bad principle.

The attention of the author had long been drawn to these defects; but he had not seriously reflected on the best modes of remedying them till the pursuit of a collateral object forced them on him. He had noticed the frequent failures of wheels, especially in carriages used for rapid motion, and all the reasons alleged by "practical men" to account for it, seemed to him so unsatisfactory, that he was led to pursue a series of experimental analysis in order to discover the cause. He found by repeated experiments, which were corroborated by every-day practice, that the wheels which would bear the greatest dead weight when at rest, were not those which proved most durable when in motion;—that the most durable wheels were not of the cylindrical, but the conical form; and that the principle of the durability consisted in the absence of rigidity. Further examination proved that the wheels called conical were not really conical, but dome-shaped, the spokes being bent into arches by the shrinking on of the hot tire. Thus, each pair of opposite spokes really formed a bow similar to that of the archer; the nave representing the hand-grip, and the felloes the nocks. It was easy to deduce from this, that the principle of elasticity was the true cause of the durability of the so-called conical wheels, and that the resilient action caused them to withstand shocks which would have destroyed those of a cylindrical form. Subsequent experiments confirmed this as a fact.

A definite object now offered itself for pursuit. In

what form of wheel could the principle of elasticity be made the most available? It was clear that the principle of the ordinary spoke wheel, with arms radiating from a centre to a periphery, was that of a construction the nearest approaching to rigidity, and some other form must be adopted, in which elasticity might have free action in every direction from which concussion would approach. But other considerations were involved. It was necessary that the wheel, though elastic, should be sufficiently strong not to break, or permanently to alter its form. It was also necessary that the periphery should be sufficiently rigid not to lose its circular shape;—in short, the principle must be, to confine the elasticity to the space usually occupied by spokes, between the centre and the periphery, in such manner that when the carriage was at rest, the axis might remain in the true centre, and in case of concussion, might slightly depart from it, and be instantly restored by the elastic action. Having well considered this principle, the author began to calculate the mechanical advantages which were to be gained in a practical point of view; as, in case they might prove trifling, the mere attainment of increased durability would not have been an object worth pursuing, at a considerable cost of time and expense. These advantages he had reason to believe sufficiently numerous.

The increased durability of the elastic wheel over the rigid one is sufficiently obvious: the former eludes concussion, while the latter in resisting it is strained or broken. The fable of the oak and the rush is familiar to most people; and the boy who catches the cricket ball

knows that his hands suffer least when he permits them slightly to recoil.

The object for which horizontal springs are placed between the axles and framework of carriages, is to diminish the concussion caused by the wheels rolling over rough surfaces. But such horizontal springs do not efficiently relieve it, as their action is vertical, or at right angles with the line of the spring; whereas the line of concussion is at an angle nearly midway between the horizontal line, which is the line of progress, and the vertical line in which the spring acts. Consequently, to act efficiently, the springs ought not to be placed horizontally, but at right angles with the line of concussion; viz., at an angle of about 22° with the horizon,—supposing the carriage to run on level ground. Therefore, an elastic wheel acting in all directions would be a great and obvious improvement to meet such a defect.

When a carriage has attained its maximum speed, the horses draw it with a less exertion of power than is required at first starting from a state of rest. As the carriage advances, every inequality of the surface over which it rolls has a tendency to restore it to a state of rest,—or, in other words, requires a greater expenditure of power to keep up the speed. With rigid wheels, every concussion which the periphery encounters is carried to the axis with undiminished force, and thus the momentum is checked, and the horses are baffled and fatigued. This evil would be materially lessened by the use of elastic wheels.

In most carriages, scarcely any provision is made to ease

lateral concussion. Therefore it would be a desirable thing to construct a wheel which might be elastic in all directions.

Having satisfied himself that the object was worth pursuing, the author began to investigate what had been done by others before him in the same field of experiment. The experimenters had been numerous, but unsuccessful; and it is sufficient to notice a few of their plans.

One of the earliest was, to substitute leathern straps between the centre and the periphery, in lieu of the rigid wooden spokes. Want of firmness, to say nothing of want of durability, was quite a sufficient defect to render any such plan ineffective.

Another plan was, to substitute spiral springs in lieu of rigid spokes. This was quite as futile as the last.

Another plan was, to substitute, in lieu of rigid spokes, springs formed in the shape of a double ellipse, radiating in the direction of their length from the centre to the periphery. It is evident that in action these springs must all have a tendency to counteract each other; and thus to all practical purpose the wheel would be as rigid as an ordinary spoke wheel, and at the same time much heavier and less firm.

Another plan was, to substitute, for rigid spokes, ribands of steel bent into the form of an S, and securely bolted at either end, to the centre and the periphery. This plan is far better than the last, as the springs would not interfere with each other's action, and would be capable both of extension and compression, and at the same time of elastic resistance; which last is absolutely necessary in order to restore the nave to the exact centre after

being disturbed by concussion. The wheel would also be very sightly in its external appearance: but the expense of construction, the want of firmness, the difficulty of efficiently securing the springs, and the necessity of constant repairs, added to the great extra weight, furnish almost insuperable difficulties to its practical utility.

The last plan that the author is aware of, is a proposition in the Mechanics' Magazine. It is, to form a double wheel, consisting of a rigid cast-iron wheel of small size, and a cast-iron ring of considerably larger size; the ring and wheel being connected together by several small circular hoops of steel, similar in form to those used to hold bunches of keys together. These rings are not to be fixed or bolted, but are to play loosely in semicircular grooves prepared for them in the castings. This wheel would possess free action, and the springs would not interfere with each other: but the defects are numerous. In action, the upper springs would be loose in their bearings, while the lower ones would have to sustain all the weight of the carriage. The noise consequent on all this would be intolerable, and the springs would be continually breaking. In short, it would be a crazy, inconvenient, and unsightly combination.

Having well considered all these different plans, the author came to the conclusion that the circular form of spring was the only one which could be efficiently adapted for a wheel, as only that form would permit free action in every position of the wheel, and only that form was capable of an efficient means of firm fastening, combining the principles of extension and compression, resisting and yielding

at the same time. The train of experiments was then commenced, and proved both costly and protracted, owing principally to the difficulty of getting workmen to execute well that which differed from their ordinary routine. The first pair of wheels was constructed on the principle of allowing the ends of the springs to play freely on rollers at the centre, increasing or diminishing the size of the circles, the backs being made thick and secured to the periphery. But the expense of construction and the rattling noise produced by the rollers caused the author to abandon this plan. Many experiments followed ere the author accomplished his object, for which he secured a patent right. The present construction of the wheel is as follows :—

A cylindrical iron ring, similar in appearance to an outer tire, but of considerably less weight, is first prepared. Around this ring are fitted eight felloes of wood, forming true segments of a circle. The joints of these felloes are accurately cut in radial lines converging to a centre; and each pair of ends is connected by a dowel as in ordinary wheels. Over these felloes an outer tire is shrunk on hot, and the whole three strata are riveted together. An outer circle is thus made, which by its mode of construction must necessarily have a tendency to preserve its circular form under all circumstances. It will be slightly resilient under concussion ; but nothing less than a positive crushing of the parts could possibly make a permanent alteration of its arched form. To the interior tire of this ring are firmly bolted at equal distances four circular hoops of steel ; a small block or raiser of wood being interposed between the hoop

and the tire as a bedding or packing. The axle-box, which supplies the place of the ordinary nave, is cast in the form of a Maltese cross; and to the projecting arms of it the four hoop-springs are efficiently secured on wooden blocks, similar to those at the periphery. One very important advantage arising from this mode of constructing the axle-box is, its capacity for containing *a circular oil-chamber round the centre of the axle-arm, so that the oil is in actual contact with it, instead of feeding by a capillary action*, and the due lubrication cannot by any possibility be impeded. In the naves of ordinary wheels this very desirable advantage cannot be attained.

It must be evident that the four hoop-springs, being all firmly bolted to the same centre and the same periphery, must all act together. No one of them can alter its form without the others doing the same; and those alterations of form must be from exact circles into ellipses. But if any alteration of form were to take place at those portions of the springs which are bedded on the blocks, they would soon work loose and probably break at the fastenings. Therefore, the springs must be so contrived, that at the bearing points the thickness and width of the metal may be so increased as to prevent all movement by their rigidity; while at the spaces between the bearings, the plates may be gradually diminished both in width and thickness, so as to afford the needful elastic action. In this mode each spring does in fact constitute a double bow; the bearings or blocks constituting the grips or hand-pieces. The elastic action therefore takes place at about an equal dis-

tance between the centre and the periphery all round the wheel. In Plate VIII. the wheel is shown front and section.

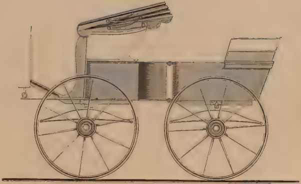
A wheel of this construction, accurately made, is in the author's judgment calculated to last as long as the carriage to which it may be applied, with the exception of the wearing part, viz. the outer tire, which of course would need renewal from time to time. Their external appearance has been generally admired by those who have seen them, as they are far lighter to the eye than ordinary wheels. If therefore their utility prove to be as great as the author has endeavoured to show, two objects will have been gained,—mechanical advantage united with graceful form.

Having been thus far successful in applying the wheels to a two-wheeled carriage, a difficulty occurred as to their adaptation to four-wheeled vehicles. For hind wheels there could be no objection, as the size leaves abundant space for the springs; but in very small front wheels the springs must necessarily be so much reduced in diameter that they would cease to be springs, and become rigid in the case of heavy carriages. For light carriages the objection would not be so great, as the metal might be very considerably reduced in thickness, in order to compensate for the reduced diameter of the springs; but still it would be disadvantageous.

In this difficulty the author called to mind the fact that wheels of unequal size in the same carriage were only a proof of defective construction, equal-sized wheels being really the desirable point to aim at. After much reflection, he constructed some models for the purpose of experiment.

CIRCULAR SPRING WHEEL.

PLATE VIII.



EQUIROTAL PHAETON

and ascertained that the lock or turn could be attained much more advantageously, by placing the central pivot or perch-bolt near the centre of the perch, between the front and hind wheels, instead of placing it over the front axle, as is commonly the case. In the common mode, the front wheels lock round on the perch-bolt nearly at a right angle with the hind ones; and in turning, one of the hind wheels serves as a pivot around which the front wheels describe a large circle. But when the perch-bolt is placed at the centre of the total length, in the act of turning, both front and hind wheels lock together, and stand on lines forming the circumference of the circle in which the carriage is intended to turn, the two axles radiating towards a common centre. Thus not only is the circle described by the common carriage larger than the improved one, but the resistance is greater;—in other words, the improved carriage will require less force to turn it. In the common carriage also, as the wheels must necessarily turn beneath the body, they must be kept small. In the improved carriage, with the perch bolt at a nearly equal distance between the wheels, the fore wheels have so large a radius that they do not touch the body in turning, and therefore may be made of the full size.

After fully ascertaining the principles of construction, the author proceeded to build a light Phaeton of the simplest kind, with equal-sized wheels on elliptic springs, without a perch, such as is shown in Plate IX.

By comparing this drawing with that of the Phaetons on the common plan in Plate V., it will be at once seen that the fore part of it possesses a much lighter appearance, being devoid of the complicated mass of framework; while

the lines of the springs, being placed at the same horizontal level, show much more gracefully. The central division into two parts, with the curved outlines, also tends very much to improve the appearance, and alter the coffin-like look which is so great a defect in the common Phaetons. The defects of this drawing are the ungraceful hind line of the body and also of the elbow. The springs are harsh and abrupt in their curves; and the spokes of the wheels make the cords of the springs look as though they were dipping downwards.

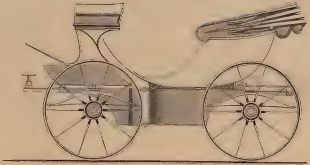
A pair of shafts were attached to this Phaeton, and a single horse, of not very powerful make, was harnessed to it. With a load of four stout men, the result was:

First. The horse drew it with great ease, as compared with an ordinary carriage of similar form and weight.

Secondly. The driver was always square behind the horse, whether locking or not, as his seat turned with the front wheels, and consequently he had the same command over his horse as in a Stanhope. In ordinary four-wheeled vehicles, serious accidents frequently arise from restive horses when locking, as in that position the driver loses the greater part of his power over them.

Thirdly. The springs, being all at one horizontal level, played exactly alike, with uniform motion, very easily, and, as one of the men remarked, "Like a boat on the water."

Fourthly. In consequence of the smoothness of the turning centres and the absence of a wheel-plate, there was none of the unpleasant rumbling noise common to ordinary carriages. For persons of delicate nerves this is a most important advantage.



EQUIROTAL CAB PHAETON.

PLATE X.

Fifthly. The carriage, though turning with perfect freedom, was yet perfectly firm, and free from tremulous motion from end to end.

It is evident that these carriages, from the simplicity of their construction, require much less labour to cleanse them; and for the same reason, their general durability must be much increased. When fitted up with the circular spring-wheels, and the improved springs hereafter described, the author conceives that they will leave little to be desired so far as regards ease of motion. The name by which he proposes to distinguish them from carriages of the ordinary class is,

Equirotal Carriages.

Having successfully conducted his experiments to their conclusion, the author commenced a series of designs for the purpose of applying the principle to every variety of carriages.

One, is a design for a Phaeton, with a Cabriolet-shaped body in front, for the purpose of driving from, and a locker seat behind, for servants. This design is not in good taste, for the sea shell form of the body does not harmonise with the straight lines of the locker; but it would be a convenient carriage for any one wishing to enjoy easy driving.

Plate X is a design for a Pony Phaeton, with the connecting framework of the lockers so constructed, that the bottom is within fourteen inches of the ground; the ends being arched upwards to rest on the elliptic springs above the axles. On the hinder locker is placed a sea-shell formed body, behind which there is room for a boy

to stand when the head is up, or to sit when it is thrown back. A low platform is placed on the front locker, and to this is attached a driving-seat, capable of being removed when the sitters wish to drive themselves from the body. The lines of this carriage harmonise well together;—the locker beneath being merely a basement, which in the construction would scarcely be seen at all, as the eye would look downwards at it in perspective; whereas in the drawing it appears much more prominent, owing to the the geometric elevation. This carriage would run very lightly behind a pair of small ponies or cobs, and look in good proportion. The locker beneath would serve as a well to carry light luggage or parcels, without the slightest inconvenience to the sitters. By removing the front driving-seat and platform, and placing a trunk there instead, a convenient light travelling carriage would be attained.

In this drawing the springs are shown extremely clumsy and ungraceful. The platform beneath the front seat projects too far forwards; the bottom curve of the body is too straight and irregular, and the elbow line at the fore part breaks abruptly into the front line; while the leather head shows too heavy in front.

A light Phaeton may be so constructed by means of cranking the axles, that the locker will be within a foot of the ground, and the level of the hind seat but a few inches above the axle-arm. The driving-seat can be raised on a platform to a sufficient height. With the knee-flap thrown up, this carriage would accommodate four persons in the hinder part, and two on the box. With the knee-

flap closed, two only could sit behind, but the head might be entirely closed by means of a folding glass shutter, and thus all the convenience of a close carriage be attained. Under the seat there would be considerable space for luggage, and also in the front locker. For travelling, the driving-seat might be removed, and very large trunks placed on the front locker. This carriage would be well adapted for infirm or nervous persons, or young children, and there would be as much leg-room as in an ordinary Britzschka, though it would require but a single step to enter it, and the centre of gravity would be so low that it would be a very difficult matter to overset it even were any one to try, while all the advantages of high wheels would be retained. It might be drawn either by a large horse or two ponies.

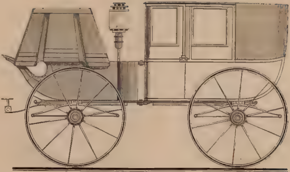
Plate XI. represents an equal-wheeled Droitzschka, the bottom within fourteen inches of the ground. The lockers are arched upwards to clear the axles. The lines of this carriage harmonise well together, the various curves falling in to each other with good effect. This is a far more convenient carriage than the ordinary Droitzschka, as the leg-room is not impeded by the necessity of allowing space for the wheels to turn under. The driving-seat is on a platform, like the Pony Phaeton; and that platform might be made deeper, if required, for the convenience of carrying parcels. Taking the driving-seat away, there would be plenty of room for trunks and luggage. Two persons could be accommodated inside; and with the knee-flap up, two children besides. Behind, there is accommodation for a servant boy; and two could sit on the box. This car-

riage is exceedingly safe, and would run very light, either with a horse or two ponies. The head could, if required, be fitted with a folding shutter to form a close carriage.

The defects in this drawing are, the too great thickness of the springs, the too great flatness of the door-top, and a want of ease in the lower curve of the door.*

Plate XII. represents a Chariot adapted for town or country use. At first sight, the lines of this carriage do not appear so graceful to a superficial observer as those of the ordinary chariots, on account of the straightness of the bottom; but a closer examination will show, that with elliptic springs placed at the same horizontal level, no other line could be so advantageously adapted. The carriage is a whole, composed of parts of equal sizes and proportions, and not filled in with heterogeneous ornaments for the purpose of covering defects. The central parts join together in lines which are portions of segmental curves; thus preventing a heavy appearance. The hind end curves upwards in an elliptic form; and the front, with a return curve somewhat resembling the light figure-head of a ship; thus denoting the line of progress. The lower line of the

* These carriages can be constructed so light that they might be easily posted with one horse; the postilion not riding, but driving from a very small and light seat in front of the luggage. By this means many persons who keep light carriages might be induced to travel by them on excursions, instead of using public vehicles. Two travellers with light luggage might thus travel in their private carriage nearly as rapidly and as economically, and with much more convenience, than by the mail. In this age of progress such a plan is well worth the attention of post-masters, the total amount of whose business might thus be much increased. The necessary arrangements would not be difficult.



EQUIROTAL TOWN CHARIOT

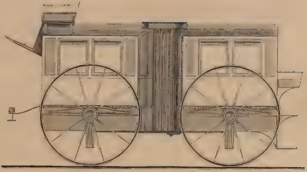
PLATE XII

hammer-cloth is made to range with the central horizontal line of the body. The lamp, instead of being ungracefully attached to the fore part of the body as is commonly the case, stands on a branching iron in the open space left for it between the body and the hammer-cloth; thus becoming a prominent object, like a classic Pharos. The general harmonious appearance of the vehicle would with unprejudiced observers immediately obtain for it a preference over ordinary carriages, saying nothing of its mechanical advantages; but the eye, after being long accustomed to arbitrary forms, seldom remains unprejudiced, and it is difficult to divest ourselves of attachments that have grown on us by the force of habit. Thus, many persons are still found to prefer the barbarous grotesquerie which has caricatured the true Louis Quatorze taste, and to look with contempt, alike on the beauty of Greek simplicity and Gothic art.

But, leaving all questions of external appearance to be decided on their own merits, and taking the mechanical advantages for granted, the question of comfort remains to be considered. In this point of view, the carriage will be found to possess qualities not attainable in any of the ordinary vehicles. Though appearing larger than an ordinary Chariot, it actually stands on a less space of ground, the axles being one foot nearer to each other than is commonly the case. But the whole of the length is usefully occupied. The body for the sitters, instead of being a cramped box confining the limbs, as the ordinary chariots do, is in reality more nearly approaching the form of an apartment, being sufficient for two persons of the very

largest size to recline at full length, without incommoding each other; while the bottom is straight, like an ordinary floor. Britzschkas, it is true, also afford a facility for reclining at full length; but from want of space above for air, they are almost suffocating to the passenger: whereas in this kind of chariot ample space is afforded for air. On looking at the drawing, it will be seen that the ordinary appearance of the side door is preserved, though it is not in reality a door, but merely a window to draw up and down as usual. From the fore part of this apparent door, the body is continued forward in a circular form; and thus the interior presents a large bow front, with a window on either hand, through which a perfect view is obtained on all sides. The floor of the body is in fact in the form of a horse-shoe. The doors open in the bow front on either side. This body is well capable of accommodating four or six people; and the locker in front will hold a very large quantity of luggage; while the coachman and footman go on the box. If required, a stand for the footman might easily be attached behind, by light iron stays or brackets. On a journey, imperials might be placed on the roof, and also on the fore locker; and supposing two persons only to occupy the interior, they might have a very convenient table before them. In addition to this, the author has contrived a very simple arrangement, by means of a large lamp below the bottom, to heat small water-pipes carried round the interior, and thus maintain a comfortable warmth in the winter-time. The ordinary mode of constructing carriages will scarcely permit this.

The principal defects in this drawing are, the absence of



EQUIROTAL OMNIBUS

PLATE XII

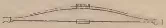
graceful curve in the springs, and the enormous disproportion of the moulding which composed the outlines of the body.

This principle of carriage construction is well adapted for Stage-coaches, as well as the Omnibuses with which the streets are crowded, and which with the advent of railroads will continue to increase.

Plate XIII is a design for an Omnibus. It is jointed in the middle, where the circular sides are made flexible like a leathern head or hood. It will turn with facility in the narrowest streets, without impeding the passage-way along the interior, as the flexible sides move in a circle. With this omnibus two horses would do the work of three: there would be great facility of access and egress; perfect command over the horses; increased ease to the passengers, greater head room, and more perfect ventilation; greater general durability, and absence of the usual rattling noise, accompanied by entire safety against overturning. This design is calculated for the accommodation of twelve inside passengers, but it might easily be lengthened to hold twenty, and two horses would draw it with the same facility as fourteen are drawn on the present plan, on account of the height of the wheels, which so much aids the draught.

After completing these designs, the author was led to reflect that the novel mode of locking was not well adapted for the use of C springs. This induced an analysis of the ordinary elliptic springs, with a view to their improvement. Upon further reflection, the reason of the double elliptic springs being easier than the single straight springs

seemed to be, the fact of the body placed on them being two removes from the concussion. It immediately struck the author that a flexile medium attached to a single spring would be a more perfect combination than a double spring, and experiments with an archer's bow confirmed his expectations. He then constructed a spring of a single plate of shear steel, and fitting the ends with adjusting screws, applied a cord of sufficient size to draw the arch to the right span. The result was, a very perfect spring of universal action. In Plates IX. to XIV. it is shown, attached to the equirotal carriages, and the annexed cut defines it more clearly.



REGULATING BOW-SPRING.

The spring is a single plate of steel tapered both ways from the centre to the ends, which are forcibly curved by the adjusting bolts. The spring is firmly fixed by the back to the cross-bar of the carriage, and the cord is attached to the axle by proper fastenings. Consequently, the cord, being flexile, will relieve the concussion of the wheel in whatever direction it may strike. It will also be seen that this spring has no tendency to break, and that by the action of the cord it will resist the upward rebound as easily as the downward pressure. There are also three other material advantages attending it. One half the usual weight of steel will suffice for its construction—the adjusting screws will adapt it at pleasure for a light or heavy

load—and being a single plate, it may be efficiently covered with paint to preserve it from rust. The author has reason to believe that this spring will be found a very perfect substitute for the unwieldy C spring and leathern brace.*

It is now upwards of two years since the attention of the author was drawn to the probable increase of public vehicles, and more especially Cabriolets and Omnibuses, which must be the natural result of railroads and other improvements in distant locomotion. With this motive he prepared the designs for the improved Omnibus, and also one for an improved Cabriolet for street use.

These designs were lying by him, when Mr. Hansom, the well-known architect of the Birmingham Town-hall, gave the first active impulse to the dormant spirit of public improvement in street vehicles, by introducing the Cabriolet which bears his name. Mr. Hansom had remarked the defects of the common Cabriolets, their inconvenient height, and danger to the passenger as well as driver. He was well aware also of the mechanical advantage of high wheels, accompanied by a low body for the sitters; but he assumed, without verifying, the common error of most carriage constructors, "that it was impossible to make a deep cranked axle to stand its work, without being enormously

* If it be desirable to convert swords and spears into ploughshares and pruning-hooks, it must be equally desirable to convert cross-bows into carriage springs. The death weapon of former ages will thus play a new part in a sphere of extensive utility, administering to the pleasures of mankind, instead of adding to their sufferings.

heavy." This error led him to contrive the very ingenious but very complicated and inefficient framework which supports the convenient though inelegant body. The quantity of wood and iron used in this framework was so great as to counterbalance nearly all the friction saved by the high wheels. The invention was taken up by a company, and the public mind was immediately excited, so that an Omnibus Association was forthwith set on foot. The disadvantages of the old Omnibuses were so great, and especially in their great height from the ground, that a new design was planned for them in which the horses were entirely sacrificed to the convenience of the passengers. The axles were cranked to get the body low; and the front wheels were so reduced in size, that the friction was very considerably increased, and what the passengers gained in ease of access, they lost by increased jarring. The horses also suffered in compound proportion; for the front springs were placed at the extremity of the crank instead of the centre of the axis, so that a considerable leverage power was added to the resistance of the front wheels.* In spite of these disadvantages, the gains of the Association were, or were supposed to be, so great, that all kinds of rival schemes were set on foot.

It was soon found that Mr. Hansom's Cabriolets, though an improvement on the old ones in public use, were far from perfect. One of the disadvantages was the mode of

* The planner of this vehicle would seem to have possessed the favourite fallacy of many carriage constructors, "that a large hind wheel pushes on a small front wheel." This prejudice has been humorously satirised by the author of the "Pickwick Papers," who makes a cab driver describe "a pair of big wheels" as forcing on a horse against his will.

entry, close to the very large wheel. A foreign patent was transplanted to England, and the vehicle being united to a newly invented spring of English growth and patent, the first of these Cabriolets plied for hire, which was not inaptly designated as a "Slice off an Omnibus." It was then first acknowledged that a deep-cranked axle "would stand its work." This vehicle was found exceedingly convenient: it was comparatively light, not weighing more than five and a half hundred weight; the entrance was from behind, free from mud and risk on entering; and the springs, which were patented by Mr William Bouhnos, were found easier than the common springs. They were double ellipses acting both vertically and laterally; a great improvement on the old method of constructing elliptic springs, which only admit of a vertical action. They must of course be more expensive to construct, from having more moving joints, and at the same time they require more frequent repairs, but still they were a considerable improvement. The defects of this Cabriolet were—that the passengers must necessarily sit sideways,—that they were exposed to continuous public view from behind, instead of the passing glance of foot passengers,—that they were much exposed to mud from vehicles following,—that their forward vision was prevented—and that the risk to the driver from the horse falling, was very great indeed. From this last defect Mr Hanson's Cabriolet is free, inasmuch as if the horse falls, the bottom almost instantly rests on the ground.

The advantages, however, of this "Slice off an Omnibus" were so great, and the mode of construction so simple and economical that a shoal of imitations were instantly put

forward. Old Chariot bodies were cut down, and numberless transformations made, some with judgment and some without. The truth is, they all more or less bear a strong resemblance to the vehicles called "go-carts" which ply for hire as a sort of two-wheeled stages in the neighbourhood of Lambeth, the deep-cranked axle being the principal distinction.

The next attempt in the "service of the public," was the introduction of a vehicle with the somewhat anomalous title of a Four-wheeled Cabriolet. This is a modification of the vehicle not long introduced under the name of a Pilentum, which, again, is a Droitzschka with a curved bottom line instead of a straight one. This Four-wheeled Cabriolet is, for passengers, the most convenient vehicle which has yet been introduced. It is a close carriage, with windows to give sight and air on each side; it is easy of access, and of more easy motion than the common two-wheeled vehicles, and is as perfectly free from mud and the intrusive gaze of foot passengers as though it were a private vehicle; and it is, moreover, safe for the driver. This is well for the public; but its great expense, weight, and consequent consumption of horse-flesh, will probably demand a larger sum per mile than the Cabriolet fares established by law, in order to remunerate the capitalists.

If those who upheld the error respecting cranked axles had analysed the subject, they would have found that the only difference in strength between a cranked axle and a straight one, consists in the extra length, and therefore the compensation must be made for it, by giving extra thickness in the direction of the strain, just the same as though

it were straight. In constructing cranked axles, the author uses a combination of wood and iron where great strength is required, similar to the mode of making ordinary perches, by which means he gets lightness combined with strength; and for very light axles, he increases the width in the direction of the strain, at the same time diminishing the thickness in the other directions. By this means he constructs axles sufficiently strong, and much lighter than by the ordinary methods.

The Author's Improved Cabriolet, to be drawn by one horse, is a two-wheeled vehicle, with the wheels from four feet six inches to five feet in height. The wheels are connected together by a deep-cranked axle, upon which the shafts are suspended by a bow-spring. The shafts are connected together by a single bar in front of the body, and to which the horse is attached. The body is suspended between the shafts, resting on the elbow projections on each side. The form of it is adapted to the form of the human body when in a sitting posture. It hangs within a foot of the ground; and the entrance is from behind, by a door which when closed is air-tight. The front is provided with ample glass windows above the level of the knees, made to open or close at pleasure, and one half of the roof above the windows is made to fold back on the other, so that in fine weather it becomes an open carriage. The two passengers sit with their faces forwards, so that the vision is unimpeded. The driver is placed behind, on a standard, with his back reclining against an elastic brace, in the same mode in which post-chaises are driven; and his arms recline on the hind part of the roof as on a desk, the reins going over the roof,

so that he can observe his horse and wheels equally well, to steer clear of obstacles. Should the horse trip, the driver can exert his whole force to save him, without fear, as he cannot possibly be thrown off by any jerk; and the bottom being so close to the ground, even if the horse falls no risk can occur either to passenger or driver. When the vehicle stops, the driver can open the door with one hand and retain the reins with the other, conveniently dismissing his fare without leaving his place. This Cabriolet therefore comprises the six points of, lightness—ease—safety—isolation between the driver and the passengers—and an open or close vehicle at pleasure.

Upon the same principle as the Omnibus and the other Equirotal Carriages, the author constructs Four-wheeled Waggons for the conveyance of coals, flour, wheat, and other heavy burdens. This kind of Waggon is entirely of sheet iron, and requires less draught power than ordinary Waggons. It has all four wheels each five feet in height; the bottom is within a foot of the ground; it may be drawn from either end at pleasure; it discharges at the side instead of the end, and one man can unload it with perfect facility.

With the present Waggons, all the coals and other heavy burdens carried, are lifted four feet high on loading, and lowered four feet on discharging. With the Improved Waggon, they are lifted one foot high and lowered one foot; so that there is a saving of human power equivalent to a six-feet lift on all the heavy burdens carried by waggon. The advantages to be gained by the facility of shifting the horses to either end, in narrow streets and wharves, need not

be dwelt on. Narrow wharves without extended sweeps or turns, are with these Improved Waggons equally available, as the larger wharves are with Common Waggons. In crowded cities, where every foot of space is valuable, this is an important advantage.

CHAPTER XVIII.

Existing Mail Coaches.—Their defects.—Author's Invention of an Improved Mail Coach.—The advantages of it.

The attention of the author having been drawn to the subject of the public Mail Coaches, he proposed the design shown in Plate XIV.; and he will now give a statement of the imperfections of the existing Mail, and the advantages to be gained by the use of the one he proposes. This will serve the reader as a general summary of the principles on which the art of carriage construction should be based, and which have been stated more diffusely in the foregoing chapters. A succinct statement of the errors in principle on which Railroad Carriages and Railroads are constructed, with several new propositions for their improvement, will conclude his work.

The construction of the Coaches hitherto used for the conveyance of the Mails has not developed to the greatest possible extent the qualities they ought to exhibit; viz. ease of draught with the minimum of friction—facility of turning round in the smallest possible space—security against oversetting, by keeping the centre of gravity low—an advantageous position for the driver to ensure his power over the horses—ease to the passengers—sufficient and secure space for the mail-bags—general durability—simpli-

city—little liability to derangement—and lastly, economy in the first cost.

Ease of draught they have not to the greatest possible extent, as the fore wheels are considerably smaller than the hind ones, and the friction is thereby increased.

Facility of turning in a small space they have not; for the fore wheel is so close to the body that it can make but a small angle, and consequently the coach must describe a large circle in going round. An unskilful driver, who would be apt to turn too short round, would therefore overset the coach.

The liability to overset is also increased by the weight being considerably above the axles, even as regards the dead load, and, above all, by passengers being carried on the roof, causing the coach to sway about with every inequality of the road.

The power of the driver over his horses, though sufficient when in a straight line, is almost lost when turning an angle. The leaders may in fact defy his efforts to control them by the reins, and the whip is his only resource.

The space for the luggage and mail-bags is small, and insecure, as is evinced by the frequent robberies which occur.

The durability is not great, as is shown by the constant repairs which are needed to the carriage framework.

They are far from simple, inasmuch as a double framework, called the upper and under carriages, is used to support the springs on which the body is fixed. The axles are also imperfect, and complicated in their wheel fastenings;

a great disadvantage, as to guard against accidents it is necessary to examine the wheels after every journey.

The carriage represented in Plate XIV. is calculated to obviate the foregoing defects.

All four wheels being of equal height—*i. e.* the front being made as large as the hind ones, the axle friction, and the rolling friction also, are considerably diminished. When the front wheels are smaller than the hind ones, a portion of the horses' power is expended in a tendency to lift their centres into a line with the centres of the hind wheels, and the trace fastening at the collar, unless relieved by the clumsy expedient of raising the splinterbar above the wheel-centres. The small wheel also has less power of overcoming obstacles, by reason of its diminished leverage; and it has also to make more revolutions round the axis. The tire consequently wears much faster. From these defects the high front wheels are free.

The facility of turning round in a small space is ensured by the substitution of central pivots or axes nearly in the centre of the framework, connecting together two separate bodies, in place of the ordinary perch-bolt usually placed at the foremost extremity of the framework. By this means the carriage is enabled to turn in little more space than its own length, without the smallest risk of oversetting it, and at the same time without increasing the length between the axles. The friction of the central pivots is also much less than that of the ordinary perch-bolt, and the carriage will follow the horses more easily, as it will not be so stiff.

The centre of gravity is kept low, by reason of the lug-

gage being placed in wells beneath the axles. The outside passengers also are seated very low, and neither passengers nor baggage are carried on the roof; and if one of the wheels should chance to come off, the carriage would not overset, but rest on the well.

The ease of the carriage is greater than that of the ordinary Mail Stages, inasmuch as it is supported on four of the regulating bow-springs, which yield readily to all inequalities of surface over which the carriage may pass: and the pole also being on springs, will not fatigue the horses by concussion.

The power of the driver over his horses in this coach is far greater than in any other four-wheeled carriage. As the horses turn, his seat turns with them, and he is constantly behind them, with his whole force capable of exertion in a *straight line*, whereas in ordinary coaches, when in the act of turning, the driver loses his command, and is occasionally pulled off his box by restive horses. The advantage here gained seems most important, as a means of avoiding risk from unquiet cattle, independently of the facility in turning, which on level ground renders it almost impossible to overset this coach.*

The space for the mail-bags is a well or wells below the axle centres, with doors opening at the ends—the hinder one

* "*Be it remembered that if the body of a coach could be made to lock with the carriage, she would go round a corner at full speed without danger.* BUT AS THIS CANNOT BE DONE———"

Nimrod. The Road, p. 120.

The author having shown that *this can be done*, calls upon this clever writer to aid with all his influence the introduction of these vehicles into the service of the Post-office, for all lines of road not traversed by steam, and also into the service of private proprietors.

immediately beneath the feet of the guard These wells are attached to the bodies; but all chance of cutting through the floor for the purpose of robbery may be prevented by the application of a sheet of thin iron loosely fastened beneath the floor-boards. The wells may be made of ordinary wood-work; but the author would recommend thin sheet iron in preference, tinned and painted, and consequently not so liable to get out of order, besides being much safer.

The general durability of this coach must be greater than that of ordinary coaches, inasmuch as the whole is upon springs except the axles and wheels. The facility of turning, and the height of the wheels also, tend to remove much of the concussion. If required, the height of the wheels may be increased still farther without raising the bodies,—by cranking the axles.

This coach is simpler than ordinary coaches, inasmuch as all the under framework, which adds so much to the weight of ordinary coaches, and gives them so clumsy an appearance, is entirely removed.

The expense of building this coach, as a branch of manufacture, would be less than that of ordinary coaches, as it is less complicated; but that of course does not refer to a *pattern* coach, which must necessarily be more expensive on account of the loss of time caused to the workmen while learning a new branch of art.

The seat of the guard is so arranged, that when seated he is sheltered from the wind in front; and when standing up, he can look over the roof of the coach to survey the road in front: and he is also in close attendance at the door.

The facility of access to the interior is rather more than in ordinary coaches, the body being larger, and far more safe also, as the inside passengers run no risk of being thrown under the wheels by the horses starting suddenly.

The outside passengers can also gain their seats with greater facility; and both they and the inside passengers are less cramped in their limbs while sitting.

As before stated, if a wheel comes off by accident, the coach would not overset, but rest on the well.

The whole of the fore body beneath the feet of the outside passengers is contrived to contain a very large quantity of luggage.

When ordinary coaches break down in an unfrequented district, there is sometimes great trouble experienced in forwarding the letter-bags. But this carriage is so constructed, that if an axle or wheel were to break, the two bodies might be separated by taking out the pivots or bolts, and thus the horses could proceed with one half; the pole being so adjusted as to fit either, and thus form a kind of curricle. In heavy falls of snow this would be an advantage, for the horses might force their way with a two wheeled carriage where a four-wheeled one would be impracticable.*

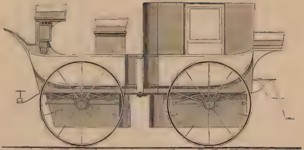
* The impediments to inland communication during the late winter, and the stoppage of the Mails by the snow, was partly owing to the form of the vehicles. The small fore wheels act on the snow somewhat like a plough. In mechanics, the worse the road, the higher should be the wheels, and soft snow is about the worst of all roads. Had the coaches been worked with the large wheels in front, the friction would have been, if not considerably diminished. A very small

The axles used for the present Mails are only greased, and the wheels require taking off every journey, — which is a very destructive process, and increases the risk of casualties. Collinge's patent oil-axles will run from four to five thousand miles after once oiling, if no accident occur. But the very best axles at present in use for ordinary wheels are those known as Mason's Improved Patent. These axles have all the advantages of Collinge's patent axles; and in addition, the boxes have three longitudinal grooves, which contain a supply of oil,—*in actual contact with the axle-arm*; whereas Collinge's axle-arms are supplied by a capillary process like a pumping action, which is liable to be checked, and then the wheel sticks fast. From this defect Mason's Improved Patent Axle is free.

The distance between the axles, and also the width of the wheel-tracks, are precisely the same as in the present Mail Coaches.

A pamphlet was lately published by Mr. Rowland Hill, advocating the reduction of all postages on letters to a penny. It has been objected to this, that the Mails would thereby either be overloaded, or would be too small for the amount of correspondence. If so, the plan the author proposes would, by the very great increase of luggage-room, remedy the defect.

portion of contrivance would have sufficed to remove the pole and splinter bar from the front and attach them to the hinder end, and then coachman, guard, and passengers, would all have marvelled alike at the effect, as the collective wisdom of Spain did at the egg of Cristoval Colon.



EQUIROTAL MAIL COACH

PLATE XIV

CHAPTER XIX.

Railroad Transit.—Clashing Opinions.—Engineers and Carriage Builders.—Railroads still only experimental.—Manchester and Liverpool Railroad.—Railroad Bubbles.—Steam *versus* Horses.—Iron tired Wheels an argument for Iron Bearings on Roads.—Defects in the Original Construction of the Manchester and Liverpool Railroad and Carriages.—Great Destructive Wear.—Causes.—Absence of Elasticity.—Springs.—Relative Speeds.—Diameter of Wheels.—Enormous Weight and Unscientific Construction of Railway Passenger Carriages.—Parallel Axles.—Flanges.—Coned Wheels.—Advantages.—Sledge-like Motion.—Improvement in the Position of Rails.—Author's Invention of a Railway Train to pass freely round a Curve.—Propositions for increased Speed on Railways premature.—Stephenson's Six-wheeled Engine.—Earl of Dundonald's Two-wheeled Engine.—Methods of constructing Railroads.—Analysis of Common Roads.—Macadamised Roads.—Imitations.—Combination of Wood and Iron for Railroads.—Durability of Wood.—Artificial Means of increasing Durability.—Author's Inventions of a Railroad of Wood and Iron.—Of a Mode of keeping the Wheels on the Rails without Flanges.—And of a Mode of keeping the Bearings of the Axles abundantly oiled without waste.—Summary of the Defects of Railroads and Railroad Carriages, and the Remedies which are desirable.—Conclusion.

As the public mind is at present largely occupied with the subject of inland transit in the particular form of Railroads, any remarks tending to elucidate details connected with their economy will not be out of place in this work.

With respect to the question of national advantage involved in the general application of railroads to the purposes

of inland transit, the disputes have been long and bitter. The advocates for railroads proclaim them all that is excellent; their opponents a ruinous absurdity. The truth lies between. They cannot be in a state of perfection, for as yet there is no existing railroad which can be considered more than experimental, either in the roadway, or the vehicles used on it. No conclusion is yet arrived at, and the experiments are costly. The engineers accustomed to stationary machines had much to learn in locomotion, and laughed to scorn the practical carriage builders. The carriage builders, on the contrary, thought it presumption in the engineers to interfere with their trade; and the result has been, that they have separated the branches of the art:—the carriage builder for railroads has become a mere wooden box maker; and the engineer has gone through a part of the process of getting at what will do, by consecutively finding out what will not do. That under such circumstances any railroad should have proved a source of profit, and especially of large profit, is remarkable.

The excitement of the public mind after the success of the Liverpool and Manchester road, called forth a host of projectors of new lines of roads, many of them more anxious to sell shares than to promote commercial transit. That speculations of this kind should prove unfavourable to the shareholders, was not to be wondered at; and therefore railroads generally were decried, because some plans for railroads were a failure. It must be clear that all roads which are not wanted must cause an unprofitable expenditure, whether rail-roads or common roads. But it is

also clear that for the purposes of stationary work, steam is a cheaper and harder working servant than animals,—provided there is constant work for it;—otherwise, animals are the best. The same principle holds good in locomotive work; and therefore common roads must be continued where the transit is limited, and not capable of sufficient increase. To make a steam-road is more costly than an animal road, because it imperatively requires a more exact level; but the nearer an animal road approaches to a level, the better it is for purposes of economy. Where the amount of transit is unlimited, and the saving of time is the saving of money, the steam-road is undoubtedly the best; and though the first cost is greater, the expense of maintenance is less, when once it has been made durable. The question can hardly yet be fairly tried. The experiments on railroads have been condensed into the space of a few years, and we look at the cost of them in a mass; but we say nothing of the cost of the experiments spread over a long number of years, by dint of which our common roads have attained their present state of perfection. The same reasons which hold good for applying iron to the bearing surfaces of our wheels, will be found ultimately to hold good with regard to the bearing surfaces of our roads, whether our draught power be steam or animals.*

* One important item in swelling the cost of railroads, is, the increased value of the land purchased for them, saying nothing of the jobbing. The common roads have been made by small portions at a time, and improved gradually. To make a new line of common road now, for a great distance, would be found a sufficiently costly undertaking.

Railroads are not a late invention, as has been supposed by many persons: they have long been in use in the coal and iron districts, where steam vehicles have also been employed on them; but in their adaptation to the purposes of general locomotion, they date their origin from that between Manchester and Liverpool. That undertaking was a costly one; and while its practicability was practically improved, the difficulty of getting capitalists to embark in it was great. Therefore, the economy of outlay was more studied than the economy of after efficiency. The lines of rails were laid so close together, in order to diminish the expense of the embankments and deep cuttings, that subsequently it was found impracticable to place the carriage bodies,—at least for passengers—between the wheels.* They were therefore placed above the wheels, and then, in order to diminish the risk of oversetting, consequent on the centre of gravity being placed too high, wheels were used of a reduced size, varying from three feet to three feet six inches. For moderate speeds—under twenty miles—these wheels might answer well enough; but when the speed varies from twenty to thirty miles and upwards per hour, they tell quite perceptibly their defects in the heavy items of repairs, both

* Since this was written, it has been stated to the author, by a Manchester resident of some eminence, that this error in the width of the rails arose, not from a consideration of cost, but simply from the sheep-like habit of imitation so strongly implanted even in the most original human beings. The rail-tracks and coal-waggons of the North of England were used of a certain width and pattern, they had been found to answer in practice, and they were imitated. It was not taken into the account that coals and cotton required differently shaped vehicles for convenient transport, and the profits from passenger trains were not anticipated.

of rails and carriages. Curiously enough, the fault has always been laid on the rails, while the carriages have been overlooked. As fast as failures took place, the weight of the rails was increased, and new varieties of supports and keys and fastenings were introduced, and rewards offered for discoveries therein.* Then came forth the "fish-bellied rails," and a large amount of discussion, ending in the experiments of Professor Barlow; one main feature of whose report is, a recommendation to leave the rails as lightly fastened down as possible, and to place the chairs or beddings on felt, or some such material as may yield slightly to pressure. The object of this is evidently to obtain the principle of elasticity, the only true means of *eluding* concussion when it is found impracticable to *resist* it. But the costly wear and tear still continues, and will continue till the carriages shall be better constructed.

Springs are used in carriages to avoid concussion on rough woods. As a consequence, the rougher the road, the

* Much trouble was experienced at the commencement of running on the Manchester and Liverpool railroad, owing to the frequent failures of the wheels. They were at last made strong enough; but then the rails were found to fail in a greater proportion. The simple fact is this. When wheels are put in motion over a plane surface, great speeds and slight inequalities are equivalent to slow speeds and great inequalities. Where the inequalities exist, concussion must take place, and the only means of eluding concussion—for resisting it is out of the question—is by elasticity. Not taking this fact into the consideration of the subject, one person makes wheels by substituting rigid plate iron forms in lieu of spokes, and another, as the author has been informed, makes solid welded wheels of wrought iron. What then? The wheels will endure; but *concussion* will transfer its attacks to the remainder of the carriage, if the rails be made too strong for it to act on them.

greater is the amount of elasticity required. The smoother the road, the lesser is the amount of elasticity required. This is supposing a given speed in both cases: but if the speed be increased, the amount of elasticity must also be increased, as the concussion will be greater in proportion. The speed of twenty miles an hour on a common road would be destructive to a carriage furnished with the short heavy springs advantageously used for that velocity on the railroads; and when the twenty is increased to thirty on the railroads, concussion and destructive wear take place. As the speed increases, small obstacles and inequalities become magnified in proportion; and therefore it becomes necessary to increase the counteracting power. The elastic agency of springs is not the only counteracting power. An obstruction which proves a formidable obstacle to a small wheel is comparatively enormous when opposed to a large one; a fact which is proved by the circumstance that as roads have improved, small wheels have been substituted for large ones: or,—where the same sized wheels have been retained, the loads have progressively increased in weight, or—the speed has been increased. Thus, on a railroad, if a wheel three feet six inches in diameter be sufficient to carry a given load twenty-five miles per hour without destructive wear, as a maximum, it must be evident that if the speed be increased, the size of the wheel must also be increased, as a compensation, in order to avoid destructive wear. That the wheels of railway vehicles are not at present of sufficient size for the speed used, is one great cause of the destructive wear and tear experienced on railroads. It were a task worthy of the scientific and experimental accu-

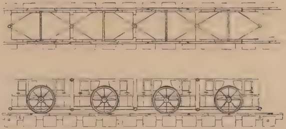
racy of Professor Barlow, to construct a table of the proportions which the diameter of wheels should bear to the weight they are intended to carry, and the speed at which they are intended to travel, in order to prevent destructive wear either by axle friction or rolling friction. If this be not done, costly indeed will be the experiments which must be gone through on a large scale ere the velocity of fifty and sixty miles per hour,—which has been pronounced attainable,—will be verified in ordinary practice.

It may be perhaps objected, that increasing the size of the heavy metallic wheels in use on railroads would add very materially to their weight. This however, even if true, might be more than compensated for by subtracting from the passenger carriages a quantity of surplus weight arising from their imperfect construction; and thus, even supposing the mean weight of the vehicle and wheels to remain the same, a great advantage would undoubtedly be gained by the diminution of the axle friction. But, if we take as an example the passenger carriages of the most approved kind, now used on the Greenwich railroad, we shall find that a considerable reduction of the total weight may be made. It is a curious thing, that on common roads, the heavy lumbering framework in four-wheeled private vehicles, technically called the "carriage," is now for the most part dispensed with, and the axles and wheels are attached directly to the body; and yet upon railroads, where there is still less necessity than on common roads, as the bearing surface is always comparatively level, we find an enormously heavy "carriage," constructed entirely of metal, supporting a "body," which, if properly framed,

would do all the work required of it, without needing any carriage whatever.

Another disadvantage attending the vehicles used on railroads is, the permanent parallelism of their axles, and their consequent unfitness to move in any line but a straight one. During the first experiments made by the elder Mr. Stephenson on the Manchester railroad, he found considerable difficulty in preventing the wheels running off the rails, notwithstanding he used very large flanges. It soon occurred to him to make the external circumference of the tires conical instead of cylindrical, the smallest diameter of the cones being on the outside of the wheel. An advantage was thereby gained, more than he had calculated on, by the comparative facility these wheels afforded for moving in a circular line, though still a circle of very large diameter. It must be evident, that if a double cone, tapering from the centre to the ends, be strongly impelled with a rolling motion on two straight parallel and horizontal bars or rails, there will be a tendency in the centre of the cone to keep a central line parallel to the two bars; but if the bars, instead of being straight, be made portions of two concentric circles, then the double cone, being violently impelled with a rolling motion, will have a tendency to a straight line, and the centrifugal force it possesses will cause the cone to increase on the outer circle, and diminish on the inner one; thus compensating by an increased and diminished diameter for the increased and diminished length of road. The wheels used on the railroad being fixed on their axles, each pair represents the double cone just described. But when four wheels are used to a car-

PLAN



Lateral Elevation of a portion of a very light flexible carriage-train for a railroad, adapted to follow easily round very quick curves, the railway being formed of brick piers, sustaining edge timbers surmounted by a capping of iron, the timber and iron breaking joints alternately

PLATE XV

riage, with the axles permanently parallel, they cannot move in a circular track without their rolling motion being partly converted into a sliding one. This is one forcible reason why curves on a line of railroad are so much deprecated, and especially when of small diameter. The sliding motion, though scarcely perceptible, must add very considerably to the friction; and the coning of the wheels must also act like a wedge, tending to thrust the rails outwards, and unsettle them from their bearings.

It must be evident that a four-wheeled carriage running in a circle, should have its axles, not parallel to each other, but in lines radiating towards the centre of that circle. This, together with the coning of the wheels, would make a nearly perfect railway carriage. But, as the coned wheels act like wedges on the rails, the rails ought to be so reinforced on their outer sides as to compensate for the outer thrust of the wheels; or perhaps a better method would be, to make the upper bearing surface of the rails parallel to the cones of the wheels, instead of a horizontal surface, and of course making the rib of the rail at right angles with that bearing surface. Stones or dirt would thus be less apt to lie on the rails.

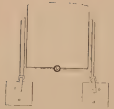
The mode of constructing the passenger carriages which the author would propose, and which he would much like to see verified by experiment, is, to construct a body of wood properly framed, and capable of containing, say twelve passengers, like an ordinary omnibus. This body should be placed on two springs of the bow and string principle before described, crossing the axle on either side. The cords of the springs should be secured to the axle, and

the whole placed between two wheels, four feet or four feet three inches in height. Two carriages being thus prepared, they should be coupled together by the jointed iron-work used for the equirotal carriages before described, leaving about three inches of space between the bodies, in order to allow the axles to accommodate themselves to the line of draught.

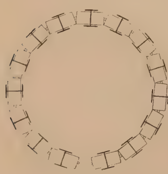
With carriages of this description, a whole train might be jointed together, without the necessity for buffing springs. There would be no jerks, as the train would be continuous, though jointed, like the vertebræ of a snake. The elasticity of the springs would be found to act in all directions, and the wheels would revolve with a greatly diminished amount of friction; thus permitting, without detriment, a greater amount of speed. The general appearance of such a train is shown both in elevation and plan in Plate XV.

Plate XVI. shows the train in a circle, and a back elevation of the train carriage.

It is a constant theme amongst those connected with railroads, to enlarge on the desirability of increasing the speed used on them. This is somewhat premature, while the speed already attained is not absolutely devoid of risk, owing to the wheels getting off the rails. To diminish this risk was the object of Mr. Stephenson in constructing his engines with six wheels,—the two first and the two last being provided with flanges, and the centre ones, which are the propelling wheels, being left without. But this method is very imperfect, inasmuch as it increases still further the difficulty of passing round sweeps, and of



Hind Elevation of a Railway Carriage, shewing the timber edge rails and their capping set at an angle corresponding to the coning of the wheels



THE FLEXIBLE CARRIAGE TRAIN DRAWN INTO A CIRCLE

PLATE XVI

course increases the lateral friction, by placing axles which are permanently parallel at a very wide distance from each other. And moreover, the difficulty of making the propelling wheels adhere efficiently on the rails when they are two out of six, is greater than when they are two out of four. Even with four-wheeled engines the difficulty of getting sufficient adhesion is considerable; and this led the Earl of Dundonald to patent a method of making two-wheeled engines, connecting the engine with its tender by a similar contrivance to that used in the army for connecting a gun-carriage with its tumbril. But the contrivances the Earl has resorted to are so extremely clumsy and inartificial, that they do not mend the matter.

The question has been much agitated as to what is the best method of constructing a railroad so as to ensure the greatest amount of durability united with efficiency and economy. In order to decide this, it will be well first to examine what are the common roads which have been found in practice to exhibit the largest amount of these qualities.

The most durable, without adverting to cost, have been those constructed of the heaviest blocks of stone with large bearing surfaces. A road of solid granite would of course be still more durable than this. But such a road would be inefficient for horses to travel on, for want of hold for their feet; and the larger the blocks used, the heavier would be the expense. And when smaller blocks are used, which give joints at sufficient intervals to prevent horses' feet from slipping, it has been found in practice, that the weights of heavy waggons which occasionally rest on a single stone, force it down below the level of the others; and

thus the softer material in which it is embedded is forced upwards. This process, repeated on stone after stone, aided by the fluctuations of wet and dry weather, at last breaks up the continuity of the pavement, and the whole is destroyed.

We may therefore assume it as a principle, that all paved roads, constructed of separate blocks of stone which do not mechanically key or bond together, must have each stone of so much bearing surface as to prevent it sinking with the heaviest weight which may be put upon it—concussion included—in the course of traffic; and if the stones be of less bearing surface, such a road must be exposed to destruction by other than fair wear.

The stones of pavements are usually bedded on gravel; and this gravel is sometimes made into concrete by the addition of lime. If an artificial bearing be thus or otherwise made, of course smaller stones may be used than when the bearing is less solid or firm. When properly constructed, such a pavement becomes a solid mass.

Were it not for the consideration that it is frequently necessary to dig up the pavement in order to get at the water and gas-pipes for the purpose of repairs, the most permanent mode of constructing it would be, to lay a substratum of flag-stones well bedded in cement, and upon that—with a sufficient depth of concrete first placed on its surface—to bed the ordinary stones forming the roadway. This would be expensive; but it would always be dry and very permanent, and save much of the expense in scavengers' work, as mud would not force up between the stones.

But, inasmuch as such a pavement would be very ex-

pensive, it would not be available for long lines of road, and it is necessary to seek some cheaper substitute. Mr. MacAdam has found this for us in the process which goes under his name. Granite, which is a tough solid stone, the fracture being very rough, is broken up into angular fragments about the size of walnuts, and is then spread on a road in depths varying from eight inches to twelve. By the gradual pressure of the wheel vehicles rolling over its surface, the fragments of granite are shaken and pressed till the flat sides for the most part bear against each other; and being rough, they do not slide, but hang together, and thus preserve the position which is least adapted to be disturbed. The small particles which are ground in the course of this process slide into the few interstices; and thus, after a time, a road is formed whose upper surface is one continuous crust, resembling a solid rock of an arching form, from which the rain-water will run off instead of penetrating through it. By the action of the wheels, portions of the upper surface are continually ground away; and this powder thus formed should be carefully scraped off, or it will form mud, acting as a sponge to keep the road wet. After long wear, the central portion of the road, which is most used, becomes too thin to sustain the weights running on it, and the arch or crust breaks into holes. The remedy then is, to pick it up and incorporate with it a fresh layer of broken stone.

Granite being expensive on account of its distant carriage, it is customary, under a system of false economy—in lessening the first cost without regard to the ultimate results—to substitute for it other and cheaper material;

such, for example, as Thames gravel, and nodules of flint, the latter broken into pieces, like the granite. The former, from its being composed of rounded instead of angular forms, must, it is evident, continually shift its position under the pressure of heavy weights, and can never bond together. It therefore always remains a loose and heavy road. The flints, though angular, being polished on their surfaces, slip past each other on pressure being applied, and are thus continually loosened; and moreover, being very brittle, and not tough, like the granite, they are rapidly crushed into powder, forming mud in wet, and dust in dry weather, the mass never binding together. To call a road of this description a Macadamised road, is a libel on the inventor.

It is clear, therefore, and it has been verified by long practice, that the Macadamised road, taking all things into consideration, is the cheapest and the best: for although the outlay is more considerable in making and keeping up, still it will enable wheel carriages to do more work in a given space of time, and with a less amount of destructive wear; so that the balance of the whole account will give a large amount of savings. The principle of the road, as before shown, consists in making it one continuous crust in an arched form, which most probably is prevented from cracking under the concussion of the wheels, by having within itself a power of vibration on the soft under surface. After a heavy rain has washed a Macadamised road quite clean on a declivity, it presents an appearance much resembling a Mosaic work.

The same principle which is found good on a common

road must also be good on a railroad; viz. a continuous equable surface. If this surface can be made perfectly solid and unchangeable, it may answer; but in default of this, it is absolutely necessary that it should possess the quality of vibration. The earliest railroads were made of wood; and to prevent rapid wear from friction, plates of iron were affixed to them. Wood was found to decay, and heavy cast-iron plates were substituted for the combination of wood and iron. For slow speeds they answered; but when greater speed became necessary, cast-iron was found unavailing. Wrought-iron bars were therefore resorted to; and these bars were firmly attached to large blocks of stone not continuous. The result was, that the bars vibrated between the intervals of their supports, but not on the supports themselves; and this, together with the alternate contraction and expansion of the bars from cold and heat, were found to be defects causing the roads rapidly to get out of repair. The evident imperfection of the roads so constructed has now led some of those connected with them to consider the practicability of using wood and iron in combination.

To consider this well, we must refer to analogous cases; *i.e.* the results obtained by the use of wood and iron in combination, where concussion has been found destructive. In ordinary carriages used on common roads this principle is very commonly applied, and it is found effective, and this is a case of very great concussion. In machinery also, it is found that for cog-wheels, wood and metal work far better together than metal alone,—that noise and concussion are removed by the use of wooden teeth working with

metal ones. Here, again, is another case of destructive concussion.* If we assume, then, that it is desirable to use wood and iron in combination, the next question is as to **the quality and durability of the wood.**

It is essentially necessary that it should possess a tolerably straight fibre, and not be disposed to warp with wet or dryness, or change of temperature. If subject to warp, the strength will be impaired by unequal strains. The durability of wood is artificially affected, principally by moisture, and more especially when the moisture is confined and cannot escape. The natural durability of wood when not exposed to artificially-hastened decomposition depends much on the quality of the glutinous substance which unites the fibres together. If it be a resin not soluble in water, as is the case with the fir tribes, the durability will be greater than in those woods whose fibres are united by gums which are soluble in water. Thus, pitch-pine, which contains much resin, will last longer than ash, which contains none. Another quality resistant of decomposition, is the quantity of tannin the wood may contain. Thus, the red cedar, which is a very light wood, will resist decomposition as long as oak, which is a very heavy wood. A third quality in wood resistant of decomposition is its de-

* At the Rotherhithe ironworks the concussion of the heavy tilt hammer was found very destructive to the engine which worked it. The intelligence of the proprietor devised a simple remedy for this. He applied two cross bars, or arms of elastic timber to the main shaft, which connects the engine with its work, at right angles with each other, and loaded the ends with heavy weights, so that they presented the appearance of four hammers. The result was, that the concussion was expended in the vibrating timber, which intercepted its progress towards the engine, and the destructive wear ceased.

gree of density, and freedom from pores, which prevent moisture from acting on it. But this last quality has little to do with the question now under discussion, inasmuch as the hard woods are too expensive to use commonly in large quantities, and for railroad bearers they would be too brittle.

As durability is so essential a quality in wood, means have of course been resorted to, to make it artificially durable. The commonest means have been, by covering it with substances impervious to moisture, such as paint, grease, pitch, or varnish. In carriages this plan answers very well, for the paint is laid on with such care that the wood is hermetically sealed against the atmosphere; but in ordinary painting this is not the case. In spite of the greatest care, flaws, cracks, and shakes remain open like mouths for the admission of moisture, which cannot again exhale, because the paint keeps it in like a cup. Therefore, for all exterior work, wood which is unpainted will generally prove the most durable.

As it must be clear that the chief natural resistants to decomposition in wood are resin and tannin, or other antiseptics, endeavours have consequently been made to impregnate wood artificially with antiseptic substances, just as fishermen and barge-owners on fresh water are accustomed to tan the sails of their vessels. The mode adopted by Mr Kyan, for impregnating wood with a solution of arsenic is said to be effective; but the author has no data to found an opinion on, whether this be correct or not.

The ordinary process of decomposition in wood by what

is technically termed "rotting," is in reality a kind of colonisation of the pores of the wood by tribes of animals or vegetables which feed on the juices uniting the fibres together. If therefore the wood be impregnated with any substance destructive to animal and vegetable life, such as arsenic or copper, or other mineral substance, or with alkalies uniting with the acids of the wood, it is evident that decomposition may be protracted for an indefinite period.

But supposing wood not to be very durable, one certain way of not unfairly diminishing its durability is, to leave it as far as possible free to the action of the atmosphere when it must be exposed at all; so that where moisture gets in, it may at least have the same chance of getting out. And this will bring us to the consideration of the best form of rail, and the best mode of securing it in its place. If this can be done simply, without fastenings involving expense of material or skilled labour, a great advantage will be gained.

In railroads newly constructed, the road varies in solidity. In some parts it consists of deep cuttings, where of course a solid foundation may mostly be obtained; in other parts it consists of lofty embankments, made of unfirm earth which can scarcely be expected to become firm till two or three years have passed away; in other parts the road is permanently unfirm by reason of the swampy and boggy nature of the ground. Therefore the mode of construction which is good in one case is not good in another. On the unfirm road, a bedding of timber work must be constructed, on which to lay the rails, and the

same on the swamps; on the firm ground, other means may be used.

For fixing iron bars, stones of considerable weight placed at short distances have been found the most eligible, because holes could be drilled in them to drive wooden plugs in, to fasten the chairs to; but the author would not recommend them in combination with wooden rails. The mode he would adopt as the best, not taking cost into the consideration, will be readily understood by a reference to Plates XV. and XVI.

The elevation in Plate XV. represents the edge line of the rail with a portion of the carriage train on it.

The hind elevation, in Plate XVI. shows the end section of the road, with the back of the carriage.

The plan, shows the road, with the carriages turned upside down.

a a are brick and cement piers or basements of sufficient bearing surface to sustain the weight to be placed on them, constructed with a deep groove on their upper surface to receive the longitudinal wooden rails *b b*. The end of the wooden rail is placed half-way upon one basement, runs quite through the next one, and half-way on the following one, where the end of the next wooden rail abuts against it, and so on throughout the line. When in their bearings, the rails are to be cemented in the joints to render them firm against the brick-work; and they are placed in their beds with a slight outward thrust corresponding to the angle of the coning of the wheel, as shown in the back elevation Plate XVI.

The joints of the wooden rails are covered by plates of

cast or wrought iron, enclosing the top and clipping down both sides of the rails. They are the exact length of the rails, allowing for expansion; and they are secured to the side of the rail by a single screw or nail in the centre on each side, and by a key through a slot cut at each end of the bar affording longitudinal motion with expansion or contraction. The plates are so placed that their abutting joints are over the pier which supports the centre of the wooden rail, and the centres of the plates cover the joints of the wood on the alternate piers.

If the piers can be made sufficiently secure without earthing up to the bottom of the wooden rails, so as to leave the whole of the wood within the piers exposed to the action of the atmosphere, the durability will be increased.

The portion of the train which is shown represents two pairs of carriages. Each pair has a turning centre above and below, so that they form a jointed four-wheeled carriage. But each pair is connected with the following pair by means of a ball and socket joint giving universal action. For this joint might at certain intervals be substituted a buffer spring, on the bow and string principle, if required, to give facility of overcoming the *vis inertiæ* at starting.

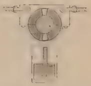
If—as the author believes—these vertebrated trains will be found adapted for more rapid speeds than those hitherto used, the next question that occurs is, how to diminish the risk of accidents, from the flanges of the wheels surmounting the rails by their great lateral adhesion on curves, when the speed is increased. The best method that occurs to him is to dispense with the flanges altogether, and substi-

tute in place of them horizontal guide-wheels, running on vertical axles attached to the bearers or brasses of the horizontal axles opposite each wheel. The form of these guide-wheels should be similar to that of the present running-wheels, viz. a conical edge terminated by a flange. The wheel being placed on the fixed vertical axle with the flange side downwards, and the upper part just level with the surface of the rail, will, when the train is going round a curve, bear against the outer rail, and if the rail be formed with a side lip or moulded edge, in extreme cases the flange of the guide-wheel will clip beneath it, and thus prevent the possibility of the train escaping without absolutely tearing the rail up from its bedding. And if by any accident a train were to get off the rail, in such cases the flat surfaces of the guide-wheels would take a bearing on the ground, and the further progress of the train would be arrested. The annexed woodcut shows the lateral framework of the carriage with the bow-spring attached, and the vertical axis and horizontal guide-wheel suspended from the bearing brasses, and passing through side bearers

MODE OF APPLYING HORIZONTAL GUIDE WHEELS ON VERTICAL AXES, TO DISPENSE WITH THE FLANGES OF THE RUNNING WHEELS.

attached to the framework to preserve it in a vertical position. Using these guide-wheels, the running-wheels would merely be made conical on their circumference, with the smallest diameter outward, as at present, but omitting the flanges altogether.

The present mode of oiling the axles of railway carriages is by keeping a continual stream of oil pouring over them by means of a syphon wick, one end inserted in an oil-can, and the other lying on the axle as it revolves. The oiling is thus very perfect, but very slovenly and wasteful. To obviate this waste, the author proposes to construct the bearers in the mode shown in the wood cuts below. A recess or chamber of large size is formed in the lower half, to contain oil, and a similar channel of small width is formed in the upper one. Two vanes or slips of thin metal are then attached to the axis, and revolving within the chamber, pass continually through the oil in the lower chamber, and thus throwing it on the surface of the axle, make the lubrication perfect. The upper cut represents the bearers laterally, with the side of the chamber removed,



IMPROVED MODE OF OILING THE BEARING BRASSES, BY AN OIL CHAMBER AND REVOLVING DIPPERS ATTACHED TO THE AXIS.

to show the chamber and vanes. Above, there should be an oil pin for feeding. The cords of the springs are attached by shackles. The lower cut is the chamber seen in cross section.

The author has not entered into any question of cost in this construction. His object has merely been to point out what seems to him the best mechanical arrangement for producing a firm and durable road, with sufficient vibration in the wood to elude concussion, and sufficient freedom in the plates to permit the necessary contraction and elongation, without any troublesome or expensive fastenings or framings. The plates and rails are alike simple in their construction. The proportions of parts and the estimates of expense must be regulated by the weight to be borne and the means at command. The summary of the conclusions arrived at in this brief analysis is as follows:—

That roads with an iron surface are as desirable in practice as wheels with an iron surface.

That railroads in their existing state are imperfect, because

They are neither perfectly rigid nor perfectly vibratory, but are alternately rigid and vibratory at intervals corresponding to the distance between the supports of the rails.

That even supposing it practicable to make a perfectly rigid road, it is not clear that it would be desirable, as concussion would be much more mischievous than on a slightly vibratory road.

But inasmuch as it is not practicable to make a perfectly rigid road, the desirable object is to construct a road slightly

vibratory, sufficient to elude concussion, but making the vibration equal in all parts.

The rails are usually fixed down, so that the alternate expansion and contraction from heat and cold tend to loosen them.

The rails are usually fixed in a vertical position, while the wheels are coned at a considerable angle with the horizon; so that the lateral thrust, when the wheels strike against the sinuosities, obtains a considerable destructive leverage.

Therefore it is desirable to fix the rail down with an outward thrust corresponding to the coning of the wheels, and by a combination of wood *clipped* with an iron rail, to maintain a continuous under-structure, while the metal above is free to expand and contract; and by this process a rail may be obtained with fewer lateral sinuosities.

That railroad carriages in their existing state are imperfect, because

The quantity of material used in them gives an enormous amount of superfluous weight, without corresponding strength or other advantages.

The wheels are of a diameter too small for the weight they bear and the speed at which they are made to travel.

The bulk or volume of the body being raised above the total height of the wheels, the centre of gravity is thereby placed so high as to cause violent oscillations when the wheels strike the lateral sinuosities of the road.

The springs which are used to relieve the concussion of the wheels act imperfectly, and that only in a vertical

position. With respect to the advancing motion of the carriage they are scarcely of any service; and laterally,—in the direction in which the flanges strike the rails,—they are of no service whatever.

The two axles in each carriage, being permanently parallel, are only adapted to advance in a straight line; so that, when drawn round a curve, the rolling motion of the wheels is partly converted into a sliding motion.

In consequence of the great extra weight of the carriages, it is necessary that they should be loosely attached to each other, or the engine cannot otherwise overcome their *inertia* at first starting. The result of this is, that the carriages strike against each other with considerable concussion: to obviate which defect, the clumsy expedient of a heavy "buffing apparatus" is resorted to; thus increasing still further the total weight.

Therefore it is desirable so to construct the carriages, that they shall not weigh proportionably more than the Omnibuses which ply on common roads—by which means the buffing apparatus may be dispensed with; that the wheels may be of sufficient height for the desired speed, without the centre of gravity being placed too high; and that the springs be of universal action, to alleviate equally, forward, vertical, and lateral concussion, while the axles are left free to adjust themselves in radii, or at angles with each other, suited to the lateral sinuosities or curved line of road.

It is left to those who are or may be interested in railroads, to determine how far the proposed plans of the author comply with these conditions.

CONCLUSION.

The author's task is ended. It was not taken up with the desire of merely "making a book." That could, of course, have been better performed by any one pursuing literature as a profession. The desire of the author has been to give to the public in simple language the results of his own experience, with the view of adding something, if possible, to the general stock of knowledge. If upon examination it be found that he has in any way contributed to remove physical obstacles to either animal or elemental locomotion, or to economise individual or national expenditure in this most important branch of progressing civilisation, his labour, so far as it has been a "labour of love," will have been rewarded.

With regard to the new inventions he has put forth, the author is aware that he must be open to the same objections that are urged against all projectors, of being "paper planners"—that is, projectors of false theories which cannot be verified in practice. He trusts that in giving a practical answer to such an objection he shall not be accused of the leading commercial vice of the age—Puffing.

A patent has been taken out for the improvements; and the brother of the author, who is a dormant partner in the firm of Hobson and Co of Long Acre, has fitted up conve-

ment working premises attached to his offices, situated No. 159, Drury Lane, where the Equirotal Carriages for private use are manufactured in the best manner, and where orders, personally or by letter, will be promptly attended to.

The Equirotal Carriages are particularly recommended to the attention of merchants and others who may wish to convey them a distance by sea, on account of the facility they offer for packing, by their simple mode of separation into two equal parts. Their facility of turning in narrow streets also renders them peculiarly advantageous for the Continental cities.

With regard to the Railway Trains, Omnibuses, Stage Coaches, Cabriolets, and Burden Waggons, the author will readily give any further information which may be required by those interested in them.

Mr. John Buchanan, of Glasgow, is manufacturing the Equirotal Carriages for private use, under the Scotch patent, and the author has appointed him his sole agent in Scotland for granting licences to those who may wish to build or use any of the other vehicles.

LONDON
PRINTED BY SAMUEL BENTLEY,
Dorset Street, Fleet Street.